NATIONAL COMMISSION ON AGRICULTURE 1976

RAINFALL AND CROPPING PATTERNS



सन्धमेव जयत



GOVERNMENT OF INDIA
MINISTRY OF AGRICULTURE AND IRRIGATION
NEW DELHI

NATIONAL COMMISSION ON AGRICULTURE 1976

RAINFALL AND CROPPING PATTERNS

Volume III





GOVERNMENT OF INDIA
MINISTRY OF AGRICULTURE AND IRRIGATION
NEW DELHI

RAINFALL AND CROPPING PATTERNS—STATE SERIES

VOLUME NO.	STATE
I	ANDHRA PRADESH
II	ASSAM
Ш	BIHAR
IV	GUJARAT
\mathbf{V}_{\perp}	HARYANA
VI	HIMACHAL PRADESH
VII	JAMMU & KASHMIR
VIII	KERALA
IX	MADHYA PRADESH
X	MAHARASHTRA
ΧI	ORISSA
XII	PUNJAB
XIII	RAJASTHAN
XIV	TAMIL NADU
XV	UTTAR PRADESH
XVI	WEST BENGAL
	सन्यमेव जयने

ĖRRAŤĀ

RAINFALL AND CROPPING PATTERNS

VOLUME III

BIHAR

Page No.	Paragraph/Table/ Appendix No.	Line	As printed	As desired
1	2	3	4	5
2	2·3(i)		montl	month
3	2 · 5(iii)	2	outside of a	outside a
3	2.6	4	suitabily	suitably
4	3 · 1	5	(3,000	(2,994
4	3 · 1	8	(18,000 sq km)	(over 18,000 sq km)
5	3 · 7	2	geographical area	reporting area
5	3.8	8	Ranchi Parganas have	Ranchi have
6	3.9	2	2.3	2.5
6	Table 6	col. 3 row 2	50-6	50-60
7	3.13	2	40 to 60 60	40 to 60
7	3·14 (i)	12-15	On the mean 25 to 26°C.	Ranchi and Hazaribagh have average daily minimum temperatures of about 18°C Else, where these range
7	3 ·14(ii)	13-14 in col. 2	The mean annual tempera-	from 19 to 21°C. The average daily maximum temperature
8	Table 7	Footnote 'ev'	(R)	(r)
8	Table 9	Col. 1-2	Biumka	Dumka
10		9	N.V	
	4·2(d)	68/69/23/99/0	each have been retained	each, and have been retained
10	4·2(d)	10	area	areas
10	4 · 2(d)	last	areas as	areas are as
11	4 ·8	1311 212	Chapara	Chapra
11	4 · 18	Carried City	Mazaffarpur	Muzaffarpur
11	4 -28	9	$Pd_3 Pu_4/W_4/M_4Ju_4$	Pd ₃ Pu ₃ W ₄
11	4 · 29	6	patna	Patna
12	4.33	4 Tomba and	30 per cent	"delete"
12	4 · 3 3	6 연극적인 기식업	60 per cent	- 64 per cent
12	4 · 33	10	62 per cent	64 per cent
12	4 -33	13	W_4M_4/Ju_4	W_4
12	.4 ·41	2	larger	larger in
12	4 -44	Ī	Arrahare	Arrah are
12	4 · 45	2	Hazaribad	Hazaribagh
12	4.45	-	net available	not available
13	4 49	5	palamau	Palamau
13	4.60	2	-	
		Col. 3 row 2 of table	10 per cent except in Battiah	15 per cent
14	4.82			except in Bettiah
15	4.88	last	G ₃ Cm ₄ Cw ₄ Cy ₄ /S ₄ -Res	G ₃ Cm ₄ Cf ₄ Cy ₄ /S ₄ -Rest
16	5.2	7	a Statea national	the Statethe national
19	Appendix 2	Col. 1 row 3	Pd ₄ M ₄ W Ba ₄	Pd ₄ M ₄ W ₄ Ba ₄
19	Appendix 2	Col, 1/12	Pd ₃ Pu ₄ /W ₄ /M ₄ /Ju ₄	Pd ₃ Pu ₄ /W ₄
19	Appendix 2	Rainfall Zone II Rainfall Pattern	$E_4 (B_2 C_2) D_1 K_3$	$E_4 (B_2 C_2) D_1 E_3$
19	Appendix 2	Rainfall Zone IV Rainfall Pattern	E ₄ (A ₁ B ₁ C ₂) E ₄	$E_4 (A_1 B_1 C_2) D_1 E_3$
20	Appendix 2	Col, 1/Rainfall Zone XIV/8		Pd ₂ Pu ₄ /W ₄ M ₄ /Mt ₄
20	Appendix 2	Col. 3/7	Garshwa	Garhwa
20	Appendix 2	Rainfall Zone XVII—Rain- fall Pattern		$C_1 E_3 (A_4) D_1 E_3$
21	Appendix 3	Rainfall Zone II—Rainfall Pattern		E_4 (B ₂ C ₂) D ₁ E ₃
21	Appendix 3	Rainfall Zone III—Rainfall Pattern	E ₄ (A ₁ B ₁) C ₂ E ₄	$\Lambda_4 (A_1 B_1 C_2) E_4$

CONTENTS

		CO	NTE	NTS								
TION												þ
INTRODUCTION												
THIRODOCTION	• •	•	•	•	•	•	•	•	•	•	•	•
METHODOLOGY	, .			•								
Rainfall Patterns	, ,		•							•		
Boundaries of Rain	ıfall Zones .											
Cropping Patterns				•	,							
Relative Yield Inde	ex of Crops .											
Livestock Patterns												
Soils												
Other Data				,								
Presentation of Info	ormation											
GENERAL FEATURE	ES				•			•		•		•
Elevation		•		•	•					•	•	
Population			•	•			•	•	•	•	•	•
Land Use				•	•	•	•			•	•	•
Soils					•			•		•		•
Irrigation			4000	227		•						
Rainfall		1	200						•	•		•
Rainfall Variability		63			3		•				•	
Temperature	, .	.9			%	•			•			•
Potential Evapo-Tra		- 6	SIE C	88509				•		•	•	•
Climatic Classificati	ion		100000	474		•	•	•	•	•	•	•
A SANISALA ZONISCE	COSTUER WIT	7F # /25F # 1		n o ppu		A N.TT'N	T T371	·cTA	cr n	. A Œሞፕ	DNC	
4 RAINFALL ZONES T	OGETHER WIT	пли	zik Ci	KOPPI	A DA	MD	LIVE	2310	CKF	ATTI	CKINO	•
Rainfall Zone I	• •	- 42	THE STATE OF		2	•	•	•	•	•	•	•
Rainfall Zone II		- 6	HH.3000	-200		•	•	•	•	•	•	•
Rainfall Zone III Rainfall Zone IV	, .	•	यन्यमे	व जग्रने		•		•	•	•	•	•
Ramfall Zone IV		•	-1-4-1	1				•		•		
												·
Rainfall Zone V		•	•				•	•		•		•
Rainfall Zone V Rainfall Zone VI									•			•
Rainfall Zone V Rainfall Zone VI Rainfall Zone VII				•								
Rainfall Zone V Rainfall Zone VI Rainfall Zone VII Rainfall Zone VIII			•						· · ·		· ·	
Rainfall Zone V Rainfall Zone VI Rainfall Zone VII Rainfall Zone VIII Rainfall Zone IX		·	· · · ·				· · ·	•			· · · · ·	
Rainfall Zone V Rainfall Zone VI Rainfall Zone VII Rainfall Zone VIII Rainfall Zone IX Rainfall Zone X			· · · · · ·								· · · · · ·	
Rainfall Zone V Rainfall Zone VI Rainfall Zone VII Rainfall Zone VIII Rainfall Zone IX											•	
Rainfall Zone V Rainfall Zone VI Rainfall Zone VII Rainfall Zone VIII Rainfall Zone IX Rainfall Zone X			· · · · · · · ·									
Rainfall Zone V Rainfall Zone VI Rainfall Zone VII Rainfall Zone VIII Rainfall Zone IX Rainfall Zone X Rainfall Zone XI												
Rainfall Zone V Rainfall Zone VI Rainfall Zone VII Rainfall Zone VIII Rainfall Zone IX Rainfall Zone X Rainfall Zone XI Rainfall Zone XI												
Rainfall Zone V Rainfall Zone VI Rainfall Zone VII Rainfall Zone VIII Rainfall Zone IX Rainfall Zone X Rainfall Zone XI Rainfall Zone XII Rainfall Zone XIII												
Rainfall Zone V Rainfall Zone VI Rainfall Zone VII Rainfall Zone VIII Rainfall Zone IX Rainfall Zone X Rainfall Zone XI Rainfall Zone XII Rainfall Zone XIII Rainfall Zone XIV Rainfall Zone XIV Rainfall Zone XV												
Rainfall Zone V Rainfall Zone VI Rainfall Zone VII Rainfall Zone VIII Rainfall Zone IX Rainfall Zone X Rainfall Zone XI Rainfall Zone XII Rainfall Zone XIII Rainfall Zone XIV Rainfall Zone XV Rainfall Zone XV Rainfall Zone XV												
Rainfall Zone V Rainfall Zone VI Rainfall Zone VII Rainfall Zone VIII Rainfall Zone IX Rainfall Zone X Rainfall Zone XI Rainfall Zone XII Rainfall Zone XIII Rainfall Zone XIVI Rainfall Zone XV Rainfall Zone XV Rainfall Zone XVI Rainfall Zone XVI Rainfall Zone XVIII Rainfall Zone XVIII Rainfall Zone XVIII Rainfall Zone XVIIII Rainfall Zone XVIIII Rainfall Zone XVIIII Rainfall Zone XVIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII												
Rainfall Zone V Rainfall Zone VI Rainfall Zone VII Rainfall Zone VIII Rainfall Zone IX Rainfall Zone X Rainfall Zone XI Rainfall Zone XII Rainfall Zone XIII Rainfall Zone XIVI Rainfall Zone XV Rainfall Zone XV Rainfall Zone XVI Rainfall Zone XVI Rainfall Zone XVIII Rainfall Zone XVIII Rainfall Zone XVIII Rainfall Zone XVIIII Rainfall Zone XVIIII Rainfall Zone XVIIII Rainfall Zone XVIIIIIIII Rainfall Zone XVIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII			BSER	VATIO								
Rainfall Zone V Rainfall Zone VI Rainfall Zone VII Rainfall Zone VIII Rainfall Zone IX Rainfall Zone X Rainfall Zone XI Rainfall Zone XII Rainfall Zone XIII Rainfall Zone XIV Rainfall Zone XV Rainfall Zone XV Rainfall Zone XV			BSER	VATIO								

APPENI	DIX										P̈́Α	GĖŚ
1	Districtwise Livestock Population-1966-	–Bihar				•					•	18
2	Rainfall and Cropping Patterns—Bihar		•				٠					19
3	Area under Principal Crops (Per cent of	Gross	Cropp	ed A	rea)	1969-7	0Bi	har	•	•		21
4	Map-Rainfall Patterns-Bihar .			•		•				•		25
5	Map—Cropping Patterns—Bihar .	•			•	•						27
6	Man-Livestock Patterns-Bihar											29



RAINFALL AND CROPPING PATTERNS

BIHAR

INTRODUCTION

- 1.1 The human population of the country is estimated to rise from the 1971 Census figure of 548 million to 935 million in 2000 AD. This rise calls for increased production. Land resources being limited emphasis has to be placed on increasing productivity per unit area. Temperature and other climatic conditions being favourable for crop production throughout the year over most parts of the country, it is possible to grow more than one crop in a year provided water, the most important input, is available. In some parts of the country, the rainy season is long enough to provide scope for double cropping. This potential is yet to be fully exploited. There is scope for increasing irrigation resources in the country, but our estimates show that the area under irrigation is not expected to be more than 42 per cent of the total cropped area even in 2000 AD, as against per cent in 1970-71. Therefore, judicious utilisation of direct rainfall and irrigation water, singly and in combination, will have to be thought of for increasing production.
- 1.2 Farming technology has so advanced that it is possible to increase crop yields even under rainfed conditions, but the choice of crops would have to depend upon the amount and distribution of the prevailing rainfall. Additionally, it will be necessary that the maximum possible quantity of rain water is conserved in ponds and pools situated either within the farm area or elsewhere, in soil profiles and underground storages so that the same could be readily used to save crops in times of water stress. Not only in rainbed farming but even under irrigated conditions, one will have to plan for the most economic and efficient use of water so as to derive maximum possible benefit from rainfall and reduce dependence on
- irrigation. This necessitates a close study of the existing cropping patterns vis-a-vis rainfall patterns aimed at determining the nature of changes needed in the former. The cropping patterns depend primarily on the soil and climatic factors but the evolution of a cropping pattern in course of time is the combined effect of soil, climate, food habits and requirements and economic factors. In the context of increasing production, it is necessary to examine the cropping patterns from a scientific angle and find out possible alternative patterns having higher potential. Accordingly, the Commission undertook a comprehensive study of the rainfall and cropping patterns of the country using taluk or tehsil as unit of area. It covered several other relevant factors such as orography, land use data, human and livestock pupulations, soil and climate, the object being to make, as far as possible, an integrated assessment.
- 1.3 Chapter 14 on Rainfall and Cropping Patterns of the Commission's Report presents a consolidated account of the data collected together with analysis of their inter-relationships on all-India basis. In this analysis the Commission has been greatly benefited by the discussions with the concerned officers of State Governments. It was realised that by condensing the vast amount of information collected from each State into the small space of a chapter, many important and peculiar features of individual States were likely to be missed and hence data and analysis of each State have been presented in separate volumes. The manner of presentation is similar to Chapter 14. It has also been considered desirable to include in each State volume the methodology and suggestions for future cropping patterns, which are practically the same as given in Chapter 14.

2 METHODOLOGY

2.1 The chief features of the study are (a) use of taluk or tehsit as unit of area for all basic data and analysis (in the case of Bihar basic data are available according to Sub-divisions and as such, Sub-division is used as the unit of area); (b) introduction of coded numerical forms to express patterns of distribution of monthly rainfall throughout the year, crops and livestock; (c) inclusion of information on orography, temperature, evapotranspiration, rainfall, soil, irrigation, land use, human and livestock populations and yield performance of crops, all of which influence in different ways and degrees the cropping patterns of a place and (d) presentation of coded information on

rainfall, crops and livestock on 1:1 million scale maps.

Rainfall Patterns

2.2 A major feature of Indian rainfall is that the Southwest monsoon season (June to September) accounts for 70 to 95 per cent of the annual rainfall throughout the country except in the south east peninsula and Kashmir and adjoining hill areas. The monsoon as well as the annual rainfall show large fluctuations from year to year but, as stated in Chapter 13 on Climate and Agriculture, there is no significant

evidence of any trend or periodicity in either of them. Considered in relation to crop production, the total annual or seasonal rainfall does not have much significance and what is important is its distribution during the period of growth of different crops. A relevant question, therefore, is whether rainfall should be examined on a weekly, fortnightly or monthly basis. The coefficient of variation (CV) of monthly rainfall is as high as 40-50 per cent even in the rainiest month of July over most or the central, northern and eastern India. In the south excluding the west coast, CV is higher and varies from 60 to 100 per cent. The variability of weekly or fortnightly rainfall being still greater, makes the use of either of them undependable as indicators of rainfall distribution. For macro-study like the present, monthly rainfall data which are more dependable and also the most convenient to handle have been used.

- 2.3 In order to relate crop production with rainfall, certain norms have to be assumed depending on the duration of the crops and their water requirements. On the basis of available information and the fact that most crops mature in about 90 days, the following broad norms have been drawn up:
 - (i) Rainfall greater than 30 cm per month (cm pm) for at least three consecutive months would be suitable for a crop like paddy whose water need is very high.
 - (ii) 20-30 cm pm for not less than three consecutive months would be suitable for crops whose water need is high but less than that of paddy, for example, maize and black gram.
 - (iii) 10-20 cm pm for at least three consecutive months would be suitable for crops requiring much less water, e.g., bajra and small millets.
 - (iv) 5-10 cm pm for three consecutive months would be just sufficient for crops which have low water requirements, e.g., moth (P. aconitifolius) and ephemeral grasses.
 - (v) Rainfall less than 5 cm pm for three consecutive months is not of much significance for crop production.
- 2.4 For denoting the year's rainfall distribution using monthly totals, a convenient code in letter symbols with numerical subscripts explained below, has been evolved. The letters A to E in Table 1 indicate the ranges of monthly rainfall and the subscripts to these refer to the number of months having these ranges of rainfall e.g. A₂ indicates two months with rainfall greater than 30 cm pm. The ranges correspond to those stated in the preceding paragraph.

TABLE 1

Code for Rainfall Data

Symbol	Monthly rainfall cm pm
A+	Greater than 30
В	2030
\mathbf{C}	10-20
D *	510
E*	Less than 5

+An examination of monthly rainfall in the country shows that except for areas in the west coast and some hill station in extreme north-east, normal monthly rainfall seldom exceeds 40 cm.

*In distributions containing ranges of rainfall covered by A or B termed briefly as A&B types amounts less than 10 cm are not so significant and their frequency is generally small. To reduce the number of combinations, D is omitted in A or B type distributions; instead E is used to denote less than 10 cm pm. Thus B₂ E₂ would denote two months of 20—30 cm pm and two months less than 10 cm pmrainfall.

The southwest monsoon months of June to September being the principal rainy season dominate the rainfall distributions of the country. To indicate the season's importance, monthly rainfall distribution during June to September is shown in brackets in the annual pattern. To the right of the bracket is the distribution for the post-monsoon months, namely, October to January and to the left that for the premonsoon months namely, February to May. In order to explain how such a coded rainfall distribution written in symbols with numerical subscripts has to be interpreted, a hypothetical example may be considered. D₁ E₃ (A₂ B₁ C₁) C₁ D₃, in which for each of the three periods, the symbols are in order of decreasing raintall which is not necessarily the calendar sequence, can be explained as under:

- (i) D₁ E₃ represents the period February to May in which one month's rainfall (usually May) is in the range of 5-10 cm and the remaining three months get less than 5cm pm.
- (ii) A₂ B₁ C₁ represents the period June to September, in which two months (usually July and August) get more than 30 cm pm rainfall, one month (September) gets 20-30 cm and the remaining month, i.e. June gets 10-20 cm.
- (iii) C₁ D₃ represents the period October to January in which October gets 10-20 cm rainfall and the rest 5-10 cm pm.

Boundaries of Rainfall Zones

2.5 Since differences in monthly, seasonal and annual rainfall are not large within short distances, linear interpolation of rainfall data is permissible. Rainfall data being point measurements, isolines for the same or nearly the same type of distribution of monthly rainfall can, therefore, be drawn. These isolines may not necessarily follow the boundaries of taluks which are taken to be unit of area in this study and

hence for delineation of boundaries the following procedure has been adopted:

- (i) Where variations are small, isolines follow the taluk boundaries;
- (ii) where variations are large, isolines delineate the zone boundaries; and
- (iii) any taluk, more than three quarters of which lies outside of a zone is not considered a part of that zone.
- 2.6 If an identical distribution is observed over two or more adjacent taluks a pattern is said to have evolved and the area covered by it is distinguished as a zone and indicated suitabily by a Roman numeral. Rainfall patterns have been identified for the whole country using the methodology described above. The data used for the analysis are the monthly normals of rainfall (1901 to 1950) and the patterns and zones are depicted on all-India map which forms part of Chapter 14 on Rainfall and Cropping Patterns of the Commission's Report.

Cropping Patterns

- The basic data for the study of cropping patterns of the country are the areas under different crops in each of the taluks. A large number of crops are grown in a taluk but most of them occupy small areas, often less than one per cent of the total cropped areas of the taluk. With a view to limiting the number of crops constituting a pattern only those crops are considered which individually occupy 10 per cent or more of the gross cropped area of the taluk. In this process, several crops have to be excluded, even though they may be otherwise important. The minimum limit has been fixed at 70 per cent, so that the number of crops, which together cover at least 70 per cent of the gross cropped area, and in which none occupies less than 10 per cent, is not large. Trial computations have shown that in such distributions any crop occupying more than 10 per cent area is rarely omitted and the number of crops hardly exceeds five. When the same distribution holds good for two or more adjacent taluks, a pattern is obtained.
- 2.8 As in the case of rainfall, percentage area coverage by crops is expressed by means of numerical subscripts affixed to crop symbols shown in Table 2. The list of crops given below is comprehensive and will hold good for all the States.

TABLE 2
Crop Symbols and Area Intervals

	Orop Symposius Com	
Cro		Symbol
1.	rice	Pd
2.	wheat	W
3.	jowar (kharif)	Jk
4.	jowar (rabi)	Jr
5.	bajra	В
6.	maize	M
7.	ragi	R
8.	small millets	Mt
9.	barley	Ва

TABLE 2 (Contd.)

	TABLE 2 (Conta.)	
Cro	p	Symbol
10.	oats	Oa
11.	gram	G
12.	pigeonpea (tur)	T
13.	pulses other than pigeonpea and gram	Pu
14.	groundnut	Gn
15.	oilseeds other than groundnut	O
16.	cotton	С
17.	jute .	Ju
18.	other fibres	Fb
19.	sugarcane	S
20.	potato	Pt
21.	vegetables	V
22.	fruits	Fr
23.	tapioca	Ta
24.	plantations	L
25.	fodder	F
26.	chillies	Ch
27.	tobacco	To
0	Area interval	Subscript
143	(per cent)	•
200	70 or more 50-70	1 2
3.25	JU-10	4

 (per cent)

 70 or more
 1

 50-70
 2

 30-50
 3

 10-30
 4

 less than 10.
 5

 the crop code contains the crop symptomiate subscript. In writing crops

The crop code contains the crop symbol and the appropriate subscript. In writing crop distribution, the first crop has always the highest area but the rest may not necessarily follow the order of decreasing areas. For example, crop distribution, C₃ Jr₄ Mt₄, means that cotton area is 30-50 per cent and jowar rabi and millets each occupies 10-30 per cent of the gross cropped area, the total being 70 per cent or more. Two or more taluks having the same distribution of crops constitute a pattern. Cropping patterns so derived have been indicated on maps of 1:1 million size.

Relative Yield Index of Crops

2.9 Besides the absolute figures, the yield of a crop has also been expressed as per cent of all-India average which is called Relative Yield Index (RYI). Relative Yield Index values have been computed for the principal crops on the basis of (1968-69 to 1970-71) data available in the records of the Directorate of Economics and Statistics, Ministry of Agriculture and Irrigation.

Livestock Patterns

2.10 The livestock patterns are relevant only insofar as these are related to production of fodder and feeds. As talukwise data were not available for the livestock Census, 1972, those of 1966 Census as published by the States have been used. The animals considered for livestock analysis are shown in Table 3 together with their symbols.

TABLE 3
Livestock Symbols

Category	Symbol
cattle:	
male	
(over 3 years)	Cm
female	
(over 3 years)	Cf
young stock	
(under 3 years)	Су
buffaloes;	
male	
(over 3 years)	Bm
female	Bf
(over 3 years) young stock	
(under 3 years)	Ву
sheep	S
goats	G
horses, mules and ponies	H AN
donkeys	D O
camels	Ca
pigs	P 🥨

The livestock patterns are expressed in coded form in the same manner as the cropping patterns.

Soils

2.11 Soil data on a taluk basis are not available for all the areas of the country. As such, soils have been discussed in a general manner using the traditional nomenclature in describing their characteristics.

Other Data

2.12 The sources of other data featuring in the study are given below:

item	source
taluk area	States' Census Reports 1971 or from the data furnished by the States in their land- use returns.
orography	maps of the Survey of India and National Atlas Organi- sation.
temperature	Climatological Tables of Observatories in India, India Meteorological Department, 1931-1960 normals.
evapotranspiration	scientific Report No. 136 of the India Meteorological De- partment, 1971.
human population	Census of India, 1971.
irrigation and land use statistics	basic data pertaining to land utilisation statistics obtained from the States and refer mostly to 1969-70.

Presentation of Information

2.13 The tables required for following the text are given in the text itself at appropriate places, whereas the basic data are appended as follows:

APPENDIX 1	Districtwise Livestock Popula- tion-1966.
Appendix 2	Zonewise Information on Rain- fall, Rainy days and Crop- ping Patterns
Appendix 3	Zonewise area under Principal Crops (per cent of Gross Cropped Area).

2.14 Rainfall, cropping and livestock patterns of each State are indicated on maps in the 1:1 million scale and given in Appendices 4, 5 and 6 respectively. In the case of rainfall patterns, the zonal numbers in State maps have been given in Roman numerals and their all-India equivalents as used in Chapter 14 of the Commission's Report have been shown in three digit Arabic numerals within brackets.

3 GENERAL FEATURES

3.1 The total geographical area of the State is 173,876 sq km. During 1969-71, there were 17 districts—6 in the plateau and 11 in the plains. The plateau occupies 46 per cent of the total geographical area. Excepting for Dhanbad (3,000 sq km) all the other districts of the plateau exceed 10,000 sq km in area, the highest being Ranchi and Hazaribagh (18,000 sq km).

3.2 The districts in the plains are much smaller in size. Area of five districts is between 4,000 and 8,000 sq km. Only three district, viz, Purnea, Gaya and Shahabad, have areas between 11,000 and

12,000 sq km. The distribution of areas of districts is given in Table 4:

TABLE 4

Areawise Distribution of Districts

plateau area ('000 sq km)	3 •0	12-14	14-16	16-18	18-20
number of districts	1	2	1	0	2
plain area ('000 sq km)	4-6	6-8	8-10	10-12	12-14
number of districts	3	2	3	2	1

3.3 The State has 58 sub-divisions. Their areas vary from less than 1,000 sq km to over 8,000 sq km. Two sub-divisions are less than 1,000 sq km and 45 are about equally divided in the area classes 1-2, 2-3 and 3-4 thousand sq km. Six sub-divisions in the plateau districts of Ranchi, Singhbhum and Hazaribagh have areas of over 5,000 sq km each.

Elevation

3.4 In plains the general minimum elevation is 40 to 70 masl (metres above sea level) excepting southern parts of Gaya, Southwest Shahabad and southern sub-division of Monghyr, where it varies between 250 and 450 masl. The maximum elevations are less than 80 masl excepting southern or southwestern parts of Bhagalpur, Monghyr, Shahabad and Gaya, where they vary from 225 to 675 masl and in Bettiah of Champaran districts (880 masl).

3.5 In plateau areas, the minimum elevation in Latehar (Palamau), Hazaribagh, Dhanbad and Santhal Parganas is generally between 300 and 450 and in Ranchi and Singbhum between 450 and 650 masl. In northern parts of Palamau and Godda of Santhal Parganas, the minimum elevation is 140 to 150 masl only. The maximum elevation varies between 500 and 1,100 masl. In Hazaribagh sub-division, elevation is about 1,000 masl and in Ranchi, Gumla and Latehar 1,100 masl. The plains are generally less than 70-80 masl in height.

Population

3.6 The total population of the State according to 1971 Census is 56.4 million. The population density which was 223 per sq km in 1951 and 267 in 1961 rose to 324 in 1971. The 1971 density is 80 per cent higher than all-India figure (182). In plateau area, the average population density is 179. But for Dhanbad (490), the population density would have been much less. Density in Palamau is only 119. The density in the plains on the other hand, is 447. There are 4 districts, Patna, Saran, Muzaffarpur and Dharbanga each with more than a density of 600. The population density in various districts is given in Table 5:

Table 5
Districtwise Density of Population

District	Area (sq km)	Population	Density per sq km
Patna	5,528	3,556,945	643
Gaya .	12,344	4,457, 473	361
Shahabad	11,320	3,939,034	348
Saran	6,952	4,279,253	616
Champaran	9,196	3,543,103	385
Muzaffarpur	7,838	4,840,681	618
Darbhanga	8,679	5,233,904	603

²⁻⁷³⁶ Agrl/76

TABLE 5 (Contd.)

District	Area (sq km)	population	Density per sq km
Monghyr	9,827	3,892,609	396
Bhagalpur	5,656	2,091,103	370
Saharsa	5,885	2,350,268	399
Purnea	11,013	3,941,863	35 8
Santhal Parganas	14,129	3,186,908	226
Palamau	12,677	1,504,350	119
Hazaribagh	18,060	3,020,214	167
Ranchi	18,331	2,611,445	142
Dhanbad	2,994	1,466,417	490
Singhbhum	13,447	2,437,799	181
State	173,876	56,353,369	324

Land Use

3.7 Forests occupy 17 and land not available for cultivation 15 per cent of the geographical area. Fallow lands account for 15 per cent. The net sown area is about 48 per cent of geographical area. In the northern plains, districts from Champaran to Purnea and Saran and Patna, have no forests. From Shahabad to Santhal Parganas and in Dhanbad about 10 to 15 per cent area is under forests. Forest area is 20 to 25 per cent in Ranchi and Singhbhum and 45 per cent in Hazaribagh and Palamau districts. Net sown area is 20 per cent in Hazaribagh and Palamau, 30 per cent in Dhanbad, 40 per cent in Ranchi and Singhbhum, 50 to 60 per cent from Gaya to Bhagalpur and Saharsa, 73 to 78 per cent in Champaran, Muzaffarpur, Darbhanga and Patna and 65 to 70 per cent in the rest of the State. Area sown more than once in the State is 32 per cent of net sown area giving a cropping intensity of 132 per cent. Cropping intensity in the plateau districts is about 110 per cent excepting Palamau (123 per cent). The cropping intensity is higher in the plains being 160 in Purnea, 150 to 160 in Champaran. Shahabad and Patna and 130 to 140 per cent in the remaining districts.

Soils

3.8 The soils in the plains are mostly recent alluvial excepting a small belt running from Saran and south Champaran to Saharsa, where these are calcareous alluvial. Along the southern boundary of Shahabad and Gaya, the soils are red and yellow whereas these are red sandy in Bhagalpur. The plateau and a major portion of Hazaribagh and Ranchi Parganas have red and yellow soils whereas soils in the extreme eastern parts of Ranchi, Hazaribagh, Dhanbad and Santhal Parganas are red sandy. A major portion of Singhbhum has mixed red and black and, in the extreme south-east, red and yellow soils. The rest of the area has red sandy soils.

Irrigation

3.9 The net irrigated area in the State in 1969-70 was 2.3 million ha which accounts for 27 per cent of net sown area. Irrigation in the districts shows wide variation. In the plateau districts, except for Palamau, area irrigated is less than 10 per cent. In Gaya, Shahabad and Patna nearly 65-80 per cent of net sown area is irrigated. The area irrigated as per cent of net sown and gross cropped areas in selected districts is given in Table 6. Nearly 36 per cent of area irrigated is by canals followed by tubewells (13 per cent) and tanks (8 per cent). 70 per cent of the irrigation in Shahabad is by canals. Champaran, Monghyr, Ranchi and Singhbhum have 45 per cent area irrigated by canals. 75 per cent of the area irrigated in Santhal Parganas is by tanks. As far as well irrigation is concerned, Patna has 30 per cent and Darbhanga and Palamau 25 per cent area irrigated by tubewells.

Table 6

Irrigated Areas as per cent of Net and Gross Sown Area

District	Net area irrigated as per cent of net sown area	Gross area irrigated as per cent of gross sown area
Gaya	80	65
Patna, Shahabad	65	506
Bhagalpur	50	40
Monghyr, Champaran, Saran and Palamau	25—30	2025
Saharasa rest State	less than $\begin{array}{c} 13 \\ 10 \\ 27 \end{array}$	same 25

Rainfall

- 3.10 The normal monthly and annual rainfall along with CV are shown in Table 7. Plateau area is more rainy than the plains, the difference in annual rainfall and rainy days being 17 cm and 17 respectively. July and August have practically the same averages, CV in August is less than that of July for plateau but practically the same for the plains. The annual CV for plateau is only 11 per cent showing the small order of variability when the whole sub-division is considered.
- 3.11 January-February rainfall is generally less than 5 per cent of annual rainfall. During March to May, rainfall is less than 5 per cent in the western districts of Patna, Gaya, Shahabad, Saran, Palamau and western part of Hazaribagh and 5 to 10 per cent in other areas. June to September are the months of heaviest rainfall accounting for 80 to

- 85 per cent of annual rainfall. October-December rainfall is 5 to 10 per cent of annual average.
- 3.12 The main features of monthly, seasonal and annual rainfall are considered below:

January—May

Rainfall during January is 1 to 2.5 cm in the plains and eastern half of the plateau and higher in the west. Rainfall in February is nearly similar. The seasonal total is 5 to 7.5 cm in the west-ern part of the plateau and 2.5 to 5 cm elsewhere. March rainfall is less than 1 cm in the plains and 1 to 2.5 cm in other areas. April rainfall is higher and ranges from less than 1 cm to the west of Patna to 5 cm in the extreme northeast. During May, rainfall increases from less than 2.5 cm to the west of Patna to 15 to 20 cm in the extreme northeast. The seasonal total is less than 5 cm in Patna, Gaya, Shahabad and southern half of Saran and rises rapidly in the north, east and south to 15 cm in the east and to more than 30 cm in the extreme northeast.

June—September

July rainfall in most of the southern half of the plains is less than 30 cm and it rises to 40-50 cm south of Ranchi and in the northeast. August rainfall is similar with reduced areas of less than 30 cm to a small belt to the north of Patna and higher than 40 cm in the south-west and northeast. Rainfall diminishes significantly in September to 20-30 cm. The seasonal total rainfall is 75 to 100 cm in the southern half of the plains and 100 to 150 cm in the rest of the State.

October-December

October rainfall is 5 to 10 cm excepting a small area near Patna, which gets less than 5 cm. November rainfall is less than 1 cm in the northern half of the plains and 1 to 2.5 cm elsewhere. Rainfall in December is negligible. The seasonal total rainfall is mostly between 5 to 10 cm.

Annual

The annual total rainfall is 100 to 150 cm except for a pocket near Patna, which gets slightly less than 100 cm and in the extreme southwest and northeast, where the amounts exceeds 150 cm.

Rainfall Variability

3.13 The coefficient of variation (CV) during January-February is 100 per cent or higher, and the seasonal CV is about 80 to 100 per cent. During March to May, CV is more than 100 per cent

but, in a small area in the northeast, May CV is only 40 to 60 60 per cent. Seasonal CV is 80 to 100 per cent in the south western part of the plains and 40 to 80 per cent elsewhere. The rainfall in northeastern area is less variable with 40 to 60 per cent CV. June CV is 60 to 80 per cent except in the northeast, where it is 50 to 60 per cent. CV is less than 40 per cent in the plateau and 40 to 50 per cent, in the plains. August CV is somewhat similar, but in the plateau there is a pocket of less than 30 per cent. September CV is higher—40 to 50 per cent in the plateau and above 50 in the plains. Seasonal CV is less than 20 per cent in the southern half of the plateau and 20 to 30 per cent elsewhere. October CV is 100 per cent in southern half of plateau and higher elsewhere. November and December CV exceed 100 per cent. Seasonal CV is 80 to 100 per cent in the plateau and higher in the plains. Annual CV is 20 to 25 per cent in the plains and less than 20 per cent in the plateau.

Temperature

- 3.14 Normals of daily maximum and minimum and mean daily temperatures for 16 observatory ktations in the State are given in Tables 8 to 10. Some of the main features are briefly considered below:
 - months of the year. January mean minimum is 9° to 10°C except from Shahabad to Santhal Parganas, and in Dhanbad and Singhbhum areas where they are 11 to 12°C. In the northern and eastern areas January is colder than December by half to one degree and elsewhere December is colder by a few tenths of a degree, the difference being negligible. In the rainiest months of July and August temperatures show little or no difference. On the mean, Ranchi and Hazaribagh have mean minimum temperatures of 22-23°C and elsewhere these are 25 to 26°C.
 - (ii) April and May are the hotest months of the year. Mean maximum in April ranges between 36° to 39°C, the highest value of 39°C is from Shahabad to Monghyr and in Singhbhum. The lowest values are about 36°C in Hazaribagh and Ranchi and in the northern districts from Champaran to Purnea. May temperature is invariably higher than April by 1° to 3°C in the west. In Purnea, May temperature is less than April by a degree and in Naya Dumka the two are the same. With the setting in of rains during June.

temperatures are reduced and in July mean maximum is between 29 to 34°C. Hazaribagh and Ranchi have averages of 29 Mean is 33°C in Palamau Shahabad to Patna and to 29.5°C. and from Elsewhere, it is 31 to 33°C. Monghyr. July to September mean maximum temperatures show little variation (0.3 to 0.5°C) except in Palamau to Patna and west of it where the differences are of the order of a degree. This important feature of every little variation in the rainy months of July to September may be noted. The mean annual temperature maximum is 29.5°C in Hazaribagh and Ranchi, 32°C from Palamau, Shahabad to Monghyr and Santhal Parganas and in Singibhum and 31°C elsewhere. The annual mean temperature is 23-24°C in Hazaribagh and Ranchi, 26-27°C from Palamau, Shahabad to Santhal Parganas, Dhanbad and Singhbhum areas and 25°C elsewhere.

Potential Evapo-Transpiration (PE)

3.15 Monthly and annual values of potential evapotranspiration (PE) worked out from Penman's formula for 16 observatory stations in the state are given in the Table 11. Brief remarks follow on their distribution. Potential evapo-transpiration in December and January is generally 5-6 cm. Rainfall is less than half the PE of these months. PE rapidly rises and is maximum in May. June PE is 15-16 cm except in Gaya and Shahabad which have higher values of 18 to 20 cm. This is much higher than the rainfall of the month over most of the State. July and August are the rainiest months and PE is 10 to 12 cm, except in Patna and Gaya, which have 2 to 3 cm higher. PE in these months is generally half to one-third of the rainfall of these months. Ranchi and areas south of Ranchi have lower PE values. September PE is similar with 10-11 cm except for 14 cm in Gaya. Rainfall of this month is generally higher than PE. The annual PE is 130 in Ranchi and to its south, 130 to 140 cm in the northern districts from Champaran to Purnea and in Palamau and Hazaribagh. PE's in the central districts are distinctly higher (145-155 cm) except in Gaya, which has a value of about 166 cm.

Climatic Classification

3.16 The State is divided into three major climatic regions. In terms of classification, Gaya and south Monghyr are semi-arid, eastern parts of Purnea, Santhal Parganas and south of Ranchi are moist sub-humid and the remaining areas are dry sub-humid. Thus, except for the area in Gaya and neighbourhood, climate is dry to moist sub-humid.

TABLE 7

Normal Monthly and Annual Rainfall and Coefficient of Variation

Plateau	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
r	2 ·1	3 · 1	2.0	1.9	5 · 1	19.6	35 ·8	34 · 4	21 ·8	8 · 3	1.6	0.5	137 - 2
n	1 .6	2.4	1 .7	1 .7	3.5	9. 9	17.0	16.9	10.9	4.3	0.9	0.4	71 -2
CV	112	92	108	83	60	46	25	18	29	83	168	203	11
per cent of annual rainfall	1.5	2.3	1 · 5	1 -4	3.7	14.3	26 · 1	25 .8	15.9	6.0	1.2	0.4	
Plains	1 3	2,3	1 2	14	3.4	14.2	20 1	23.0	13-9	0.0	1 • 2	0 -4	
r	1 ·4	2.0	1 · 1	1.6	4 · 8	17.2	31 -1	31 •4	22.5	5.9	0.9	0.4	120 -3
n	1 · 2	1.6	0.9	1 • 2	2.7	7.5	13 -1	13 •4	9 · 1	2.5	0.5	0.3	54 •0
CV	106	90	120	103	55	49	27	26	35	91	196	241	14
per cent of annual													
rainfall	1 • 2	1 ·7	0.9	1 · 3	4 .0	14 • 3	25 .9	26 · 1	18.7	4 • 9	0.7	0.3	

r-rainfall in Cm

n-number of rainy days

CV-Coefficient of Variation (%) of rainfall (R)

 $\begin{tabular}{lll} TABLE & 8 \\ \begin{tabular}{lll} Normals & of & Daily & Maximum & Temperature & (°C) \\ \end{tabular}$

Station	Jan	Feb.	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Bihar plateau													
Dumka	25 • 3	28.0	34 ∙0	38 ⋅0	37 • 9	35 · 1	31 ·8	31 ·6	31 •9	31 · 5	28 - 7	25 .9	31 •6
Daltonganj	24 •4	27.0	33 •0	38 • 3	41 .6	38 • 3	32.5	31 • 5	30.9	31 .2	28 ·1	25 · 1	31 .8
Hazaribagh	22 .8	25 ·1	30 .9	35 ⋅8	38.0	34 • 6	29 • 5	29 • 2	29 · 5	28 .6	25.6	28 ·1	29 • 5
Dhanbad	24 - 7	27 •4	33 •2	37 -6	38 ·8	35.9	31 .2	30 ·8	31 ·2	30 ⋅6	27 .8	25 -2	31 •2
Ranchi	23 -6	25 • 9	31 .2	35.9	37 • 9	34 - 2	29 ·1	28 -9	29 · 2	38 • 5	25.7	23 • 7	29 • 5
Jamshedpur	26 · 7	29 • 2	34 • 6	38 - 7	40.0	36.5	32,0	31 .8	32.1	36,1	29 - 1	26.8	32 • 4
Chaibasa	26 - 5	29 · 2	34 · 7	38 •9	40 · 5	36.7	31 -7	31 •4	31 .7	31.0	28 · 5	26.6	32 - 3
Bihar plains					ONE		9						
Motihari	22.9	25 •4	31.5	36.0	36 .7	34 • 6	32.5	32.2	32.0	31 · 3	28 .0	24 • 2	30 .6
Darbhanga	23.6	25.9	31 .7	35.9	36 • 4	34 - 5	32 •4	32 ·1	32.2	31 -4	28 - 7	25 • 2	30 .8
Purnea	24 · 3	26.6	32.2	36.0	35 -1	33 • 2	32.0	32.9	32.2	31 · 5	28 .8	25.5	30 -8
Patna	23 •6	26.3	32.9	37 • 6	38 - 9	36.7	32 -9	32 · 1	32.3	31 .9	28 -9	24 -9	31 .6
Bhagalpur	24 .0	27 • 4	33 ⋅0	37 • 9	38 -3	35.3	32.5	32.3	32.5	32.0	29 .0	25 - 5	31 .6
Sabour	23 .6	26 · 4	32.8	36 .9	37 -4	34.9	32 • 3	31 •9	32 · 1	31 •2	28 • 3	24 .8	31 -1
Jamui	24 ·4	28 .3	33 •9	39 · 2	40 .2	37 -2	32 .6	32.3	31 .9	31 •4	29 ·1	25 .9	32.2
Dehri	23 ·8	27 · 7	33 .5	3 9 · 3	42.0	38.9	33 •0	32.3	32.0	31 .8	28 -9	25.6	32 •4
Gaya	24 . 5	27.0	33 -7	39 •0	41 ·3	38 ⋅6	33 · 5	32 •4	32.6	31 •2	28.5	25 ·1	32 • 3

TABLE

Normals of Daily Minimum Temperature (°C)													
Station	Jan	Feb	Mar	Apr	May	June	July	August	Sept	Oct	Nov	Dec	Annual
Dhar plateau													
Biumka	10.6	13 -2	18 •4	22 • 7	25 • 5	26 0	25 • 3	25 - 1	24 - 7	21.6	15 -1	11 ·4	20.0
Daltonganj	9 • 4	11 -7	16 · 1	21 -2	25 • 4	27 •6	25 - 5	25 · 1	24 • 4	20 · 2	12.8	8.8	19.0
Hazaribagh	9.6	12.0	16.7	21 •4	24 4	24 • 7	23 •2	23 •0	22 4	18.7	12.7	9 • 4	18 .2
Dhanbad	12 · 1	14.5	19 • 2	23 -5	25 -9	25.9	24 -8	24 .8	24 • 3	21 .7	15.6	12 4	20 .4
Ranchi	9.9	12.2	16.7	21 ·1	24 .0	23 -9	22.6	22 -4	21.9	18 .5	13.0	9.9	18.0
Jamshedpur	11 .8	14 ·3	18.7	23 .7	26 ·8	27 •0	25 .9	25 .7	25 •4	22 .2	15.5	11 -6	20.7
Chaibasa	12.0	14 • 4	19 - 3	24 -1	26 · 8	26 - 7	25 · 3	25 ·0	24 - 7	21 .6	15 -4	11 .7	20 .6
Bihar plains													
Motihari	8.9	10.2	15.0	19 •9	24 • 2	25 · 7	25 · 3	26.0	25.2	21 -1	13 -8	9 · 7	18 .8
Darbhanga	10.0	11.6	16.3	21 · 3	24 • 7	26 0	26.2	26.2	25.8	22 · 3	15.2	10 ·8	19 • 7
Purnea	8 · 8	11.1	15.5	20.5	23.9	25 •4	25 • 9	25.9	25 • 3	21 .5	14 •4	9.8	19 0
Patna	11.0	13 •4	18.6	23 -3	26.0	27 1	26 - 7	26 •6	26 • 3	23 •0	16 -1	11 .7	20 .8
Bhagalpur	11 ·8	14 · 3	19 • 1	23 -6	25.7	26 •4	26 • 2	26.9	25.9	23 -1	16.6	12 ·8	21 -0
Sabour	8 •4	10.7	15.7	21 .2	24 .9	26 · 3	26 ·3	26.3	25 · 8	21 •9	14 · 0	9 • 1	19 · 2
Jamui	10 • 9	13 -3	18 • 9	23 .7	26.6	27.3	26 •3	26.0	25 · 5	22 · 1	14 -9	11 •4	20.6
Dehri	11 -6	14 · 2	19 · 1	24 • 2	28.0	28 ·1	26 •4	26 • 1	25 · 5	22.0	15 ⋅0	11 •9	21 .0
Gaya	10 · 1	12-2	17 •4	23 •0	27 -4	28 • 2	26 ·3	25.9	25 •6	21 • 7	14 • 1	9.9	20 · 2

 $\begin{tabular}{lll} \textbf{TABLE} & 10 \\ \hline \textbf{Normals of Daily Mean Temperature (°C)} \\ \end{tabular}$

Station	Jan.	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Bihar plateau	·····												
Dumka	18.0	20 •6	26 · 2	30 ∙4	31 • 7	30 •6	28 •6	28 -4	28 · 3	26 •6	21 •9	18-7	25 .9
Daltonganj	16.9	19 • 4	24 ·6	29 ·8	33 · 5	33 ·0	29 .0	28 • 3	27 -7	25 · 7	20 · 5	17.0	25 · 5
Hazaribagh	16.2	18 ·6	23 ·8	28 -6	31 -2	29 • 7	26 •4	26 ·1	26 ⋅0	23 ·6	19 •2	16 · 3	23 -8
Dhanbad	18 -4	21 .0	26.2	30 ⋅6	32 -4	30 •9	28.0	27 · 8	27 ·8	26 •2	28 .7	18 · 8	25.8
Ranchi	16 ·8	19 · 1	24.0	28.5	31 -0	29 ·1	25.9	25 • 7	25 -6	23 • 5	19 ·4	16.8	23 - 4
Jamshedpur	19 -3	21 .8	26.7	31 .2	33 •4	31 ·8	29.0	28.8	28 ·8	26.9	22 •3	19 • 2	26.6
Chaibasa.	19 · 3	21 .8	27 •0	31 · 5	28 • 5	31 -7	28 • 5	28 · 2	28 • 2	26 · 3	22 .0	19 -2	26 - 5
Bihar plains Motihari	15 -9	17 ·8	23 ·3	28 .0	30.5	30 · 2	28 •9	29 ·1	28 •6	26 -2	20 ·9	17 .0	24 · 7
Darbhanga	16.8	18 -8	24 .0	28.6	30 ⋅6	30 •3	29 ·3	29 •2	29 •0	26 • 9	22.0	18 .0	25 · 3
Purnea	16.6	18.9	23 •9	28 · 3	29 · 5	29 ·3	29 •0	28 -9	28 · 8	26 · 5	21 .6	17 -7	24 ·9
Patna	17 ·3	19 •9	25 ·8	30 • 5	3 2 · 5	31 -9	29 ·8	29 -4	29 -3	27 · 5	22 .5	18 - 3	26 · 2
Bhagalpur	17.9	20.9	26 ·1	30 ·8	32 .0	30 •9	29 ·4	29 -3	29 •2	27 ·6	22 .8	19 - 2	26 •4
Sabour	16.0	18 •6	24 · 3	29 ·1	31 •2	30 •6	29 · 3	29 -1	29 •0	26 -6	21 -2	17.0	25 - 2
Jamui	17.7	20 .8	26 ·4	31 -5	33 •4	32 • 3	29 · 5	29 •2	28 - 7	26 ·8	22.0	18 · 7	26 -4
Dehri	17.7	21 -0	26 -3	31 .8	35 •0	33 • 5	29 -7	29 ·2	28 ·8	26 •9	22 .0	18 ·8	26 · 8
Gaya	17 · 2	19 ·6	25 .6	31 .0	34 • 4	33 -4	29 -9	29 · 2	29 · 1	26.3	21 · 3	17 - 5	26 -3

TABLE 11

Normal Monthly and Annual Potential Evapotranspiration (mm)

Station	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Bihar plateau Nayadumka	65 • 6	86 • 5	139 · 6	175 ·4	193 •8	153 · 1	127 •4	122 ·8	117 · 3	114 · 5	79 -9	61 •4	1437 •9
Daltonganj	67 •4	82.6	132.5	167 ⋅6	199 •2	162 • 9	118 · 3	103 · 2	106 ·3	111 -1	75 •4	56 · 3	1388 • 3
Hazaribagh	70 · 2	90 •8	144 •4	176 • 1	193 ·8	142 • 2	104 •0	102 · 3	96 ·3	105 · 1	7 7 ·7	63 .0	1366 • 5
Dhanbad	8 0 ·9	103 .6	164 · 1	197 - 2	198 -0	168 · 5	125.0	115 · 5	110.9	114 -2	93 ·7	76 • 7	1548 ·8
Ranchi .	66 · 5	86 •3	135 - 3	165 •0	184 •6	134 •9	99 · 3	95 ·8	97 •9	101 -9	75 -1	60 ·8	1304 •0
Jamshedpur	72.8	94 • 2	144 •9	179 ⋅0	200 ·8	151 -9	114 ·1	107 •9	107 •9	111 ·7	85 -1	67 -1	1438 ·0
Chaibasa.	69 • 5	88 • 5	137 •0	162 •4	176 · 5	128 • 7	100 ·8	95.7	94 ·1	103 ·1	80 ·8	64 ·8	1302 - 2
Bihar plains Motihari	48 •6	67 •9	124 ·1	166 •1	196 ·3	153 -4	122 · 7	115.0	111 -4	111 -4	69 ·1	46 ·0	1332 • 6
Darbhanga	52 •0	71 ·1	126 · 1	170 · 2	205 -6	152 · 3	123 -9	116.8	108 · 6	112.6	73 •1	50 ∙0	1362 · 9
Purnea	55 ⋅2	76 · 6	131 •7	167 · 6	178 -7	133 · 5	117 -2	113 -2	108 ·8	111 -5	73 -6	51 ·8	1320 -1
Patna	63 • 5	8 7 ·0	147 - 5	118 -9	218 -6	166 •4	139 · 5	114 -6	114 - 2	122.0	81 •3	60 •1	1504 · 3
Bhagalpur	65 • 1	92 ·3	150 .6	201 -9	212 •9	147 ·1	114 -9	111 -1	109 · 2	115.9	83 •0	62 •4	1467 •0
Sabour	55.9	78 ·6	142 ·1	186 •4	199 •9	142 · 6	114 ·8	108 -2	105 · 7	111 .6	74 ·8	53 ()	1374 0
Jamui	62 •6	90 • 2	145 ·8	192 ·3	218 -5	164 •0	115 -9	109 •4	109 · 2	112 ·4	78 - 2	59 •4	1458 - 5
Dehri	65 • 5	94 · 1	149 -7	1 89 · 5	217 · 1	180 · 7	119 -9	111 •0	111-1	118 •4	0·18	62 · 1	1500 -7
Gaya	70 • 5	94 •8	162 •1	209 -1	250 -3	202 •4	140 -5	122 •9	135 -6	122 -3	85 · 5	64 · 8	1661 -4

4 RAINFALL ZONES TOGETHER WITH THEIR CROPPING AND LIVESTOCK PATTERNS

4.1 The State is divided into 17 rainfall zones. These are given below together with the sub-divisions and their approximate area.

Rainfall Zone	Rainfall pattern	Number sub- divisions	Area (są km)
i	E_4 (B_2C_2) E_4	2	3504
1.1	$E_4(B_2C_2)D_1E_3$	i	2665
Ш	$E_4(A_1B_1C_2)E_4$	1	2629
17	$E_4(A_1B_1C_2)D_1E_3$	1	2012
V	$\mathrm{E}_4(\mathrm{A}_1\mathrm{B}_2\mathrm{C}_1)\;\mathrm{E}_4$	1	1420
VL	$E_4(A_1B_2C_1)D_1E_3$	9	15152
VII	$E_4(A_2B_1C_1)E_4$	1	4950
VIII	$E_4(A_2B_1C_1)D_1E_3$	13	46147
ŧΧ	$E_4(A_2B_2)D_1E_3$	2	8854
X	$D_1E_3(B_2C_2)D_1E_3$	3	7672
XI	$D_1E_3(A_1B_1C_2)D_1E_3$	1	2431
X11	$D_1E_3(A_1B_2C_1)D_1E_3$	ì	3475
XIII	$D_1E_3(A_2B_1C_1)D_1E_3$	5	14903
XIV	$D_1E_3(A_2B_2)D_1E_3$	14	50133
XV	$C_1\mathbf{E}_3(\mathbf{A}_2\mathbf{B}_2)C_1\mathbf{E}_3$	1	1782
XVI	$C_1E_3(A_3B_1)D_1E_3$	1	2666
XVII	$C_1E_3(A_4)D_1E_3$	1	1934
			77.777

- zones is provided below before taking up their consideration in detail individually.
 - (a) The zoning of the State has been examined using rainfall data for the various sub-divisional stations. The months of February to April get less than 5 cm pm throughout the State. In May, however, about half the sub-divisions get more than 5 cm and three more than 10 cm.
 - (b) November to January are months of low rainfall and receive less than 5 cm pm in the entire State. October has more rains and the amounts are more than 5 cm excepting five sub-divisions, viz., Patna (2) Gaya (3) Naya Dumka gets more than 10 cm.
 - (c) July and August are the months receiving highest rainfall and there is no sub-division with less than 20 cm pm in these months, coded as (B2). B2 C2 is the lowest distribution and covers half a dozen sub-divisions, two each in Patna and Bhagalpur and one each in Santhal Parganas and Saran districts. The highest A₄ is in extreme northwest sub-

division of Kishanganj, A₃ B₁ in adjoining Araria and A₂ B₂ and A₂ B₁ C₁ include 60 per cent of the sub-divisions.

(d) The patterns of distribution for the three seasons combined would have been small, only seven listed in (c) above but for May and October, which receive more than 5 cm over large parts of the State. Combining (a) and (c) the State has 17 patterns and hence the State is divided into 17 rainfall Ten of these cover one subdivision each have been ratained as their area are large. Two patterns, D₁ E₃ (A₂ B₂) D₁E₃ and E₄(A₂B₂C₁) D₁E₃, include 13-14 sub-divisions each and together account for nearly half the sub-divisions of the State. In area too, they are 46-48 thousand sq km each and together account for 55 per cent of the area of the State. The distribution of zonal areas as follows:

<i>area</i> (*000 sq km)	Nnumber of z on es
1-2	3
25	10
15	2
46	J
48	-
Rainfall Zone I—E ₁ (B ₂ C ₂)E ₃	

4.2 An introductory description of the rainfall 4.3 The districts, sub-divisions and the cropping

Cropping Pattern	Sub-division	District
Pd ₃ W ₄	Bihar	Patna
$Pu_3Pd_4W_4$	Barh	••

- 4.4 The annual rainfall is 100 cm. August receives a rainfall of 30 cm followed by July (24-28 cm), June (14 cm) and September (19 cm).
- 4.5 Area under paddy is nearly 50 per cent in Bihar sub-division and 25 per cent in Barh. Wheat area is 10 to 15 per cent and that of pulses 24 to 33 per cent of the total.
- 4.6 The average yield of rice in Patna district is 90 per cent of all-India average yield. For an irrigated erop, the yield is low. The Relative Yield Index of wheat is 84 per cent and it is low.
- 4.7 Male cattle and goats have about the same percentage. There are 10-12 per cent of female and young stock of buffaloes in Patna district. The district pattern is: Cm4 G4 Cf4 Cy4/Bf4.

Rainfall Zone $H \leftarrow E_4(B_2C_2)D_1E_3$

- 4.8 Only Chapara sub-division of Saran district constitutes the zone, which has an area of 2665 sq km.
- 4.9 July and August receive 28-30 cm pm. rainfall and September gets 20 cm. Average rainfall in June is 14 cm and in October 5 cm.
- 4.10 Rice and maize each occupy above 25 per cent of cropped agea. Wheat is 16 per cent and barley 7 per cent. The pattern for the sub-division is: Pd₄ M₄ W₄ Ba₄.
- 4.11 Yield of rice in Saran district is 60 per cent of all-India average yield. Irrigation is negligible and the crop is rainfed. Maize yield is 120 per cent and 33 per cent more than the State average. Only 5 per cent of the crop area is irrigated. Rainfall distribution is adequate and the yield is satisfactory. Though wheat is irrigated to an extent of 60 per cent, yield in the district is only 70 per cent of all-India. which is low.
- 4.12 Of all the livestock, goats dominate in Saran district followed by male cattle. The pattern is: $G_3 \text{ Cm}_4 \text{ Cf}_4/\text{Cy}_4$.

Rainfall Zone III- E4(A1B1C2)E4

- 4.13 Nawada sub-division of Gaya district constitutes the zone, with an area of 2629 sq km.
- 4.14 The annual average rainfall is about 100 cm in 57 rainy days. July and August are the rainiest months with a rainfall of 27 and 31 cm respectively. June has a rainfall of 12 and September 18 cm.
- 4.15 Paddy covers about 50 per cent of cropped area followed by pulses (29 per cent) and wheat (11 per cent). The pattern is: Pd₂ Pu₄.
- 4.16 Rice yield in Gaya district is 72 per cent of all-India average yield. The crop is entirely irrigated but the yield is low. Wheat yield is 64 per cent though half the area is irrigated.
- 4.17 Male cattle are in larger number in the district followed by goats. The pattern is: Cm₄ G₄ Cf₄/Cy₄.

Rainfall Zone IV— $E_4(A_1B_1C_2)D_1E_3$

- 4.18 Hajipur sub-division of Mazaffarpur district constitutes the zone, which has an area of 2,012 sq km.
- 4.19 Rainfall of the sub-division is about 110 cm. August is the rainiest month with 31 cm followed by July (27 cm.), June (15 cm), September (20 cm) and October getting slightly higher rainfall than zone III. The distribution is practically the same as for Zone III.
- 4.20 Paddy occupies about 30 per cent of the cropped area and maize 21 per cent. Wheat and other pulses each are about 10 per cent in area. The pattern is ; $Pd_4 M_4 W_4 Pu_4$.

- 4.21 Rice yield of Muzaffarpur district is 61 per cent of all-India average yield. This may be due to inadequate rainfall and also to lack of irrigation.
- 4.22 Goats account for 36 per cent of livestock in Muzaffarpur district and the pattern is: G_8 Cm_4 Cf_4/Cy_4 .

Rainfall Zone V-E₄(A₁B₂C₁)E₄

- 4.23 This zone comprises only one sub-division, viz., Jehanabad of Gaya district, which has an area of 1,420 sq km.
- 4.24 The annual rainfall in the zone is about 110 cm in 55 rainy days. August is the rainiest month (33 cm) followed by July (30 cm), August (21 cm) and June (13 cm.).
- 4.25 The main crops of the sub-division are paddy (66 per cent), Wheat (8 per cent) and other pulses (13 per cent). The pattern is: Pd₂ Pu₄/W₄. This
- sub-division forms part of a big cropping zone extending over several sub-divisions.
- 4.26 In Gaya district yield of parry is 72 per cent of all-India average yield, though the crop is entirely irrigated. Wheat yield is 64 per cent of all-India yield though the crop is irrigated to an extent of 50 per cent, the yield is low.
- 4.27 The livestock pattern of Gaya district is: Cm₁ G₄ Cf₄ Cy₄.

Rainfall Zone VI-E₄(A₁B₂C₁)D₁E₃

4.28 The districts, sub-divisions and cropping patterns of the zone are:

district Sub-division Cropping pattern Saran Gopalganj Pd4M4W4S4Ba4 Begu Sarai Monghyr M₃ W₄ Pd₄ Khagaria Monghyr Pd₃ Pu₄ W₄ Jamui Pd₂ Pu₄/W₄/M₄/Mt₄ Buxar Shahabad Pd3Pu4/W4/M4/Ju4 Patna Sadar Patna Pd3 Pu4 Patna City Dinapur

4.29 The zone covers entire Monghyr district and a good part of Patna besides one sub-division each of Saran and Shahabad districts. The total area of the zone is over 15,000 sq km (7-8 per cent of the geographical area of the State). Excepting for Patna sadar and patna city sub-divisions which are less than 1,000 sq km each, the areas of the other sub-divisions vary between 1,100 and 3,400 sq km, the largest area being of Jamui (3,400 sq km).

- 4.30 Excepting Jamui and Monghyr, the whole zone is plain. In Jamui the elevations range from 250 to 650 masl while the maximum elevation in Monghyr is 250 masl.
- 4.31 Forests and land not available for cultivation is about a third in area and fallow lands are 13 per cent. Net sown area is 52 per cent. In Patna 18 per cent land is not available for cultivation and the sown area is 76 per cent. Soils are mainly recent alluvial.
- 4.32 The annual rainfall is 120 cm and half of this is received during July (31 cm) and August (29 cm). June rainfall is only 18 cm and that of September 22 cm May gets nearly 5 cm and October 7 cm of rainfall.
- 4.33 There is some diversity in the cropping pattern in this zone. Excepting Khagaria and Begu Sarai where maize is 40 per cent, remain-20 per cent and paddy 10 per cent, remaining 7 sub-divisions have paddy area as largest, varying from about 30 per cent in Gopalganj to 60 per cent in Jamui. In all, four patterns cover these seven sub-divisions. Patna and Dinapur sub-divisions have 45 per cent paddy and more than 25 per cent 'other pulses', the pattern being: Pd₃ Pu₄. Jamui with 62 per cent paddy has Pd₂ Pu₄ pattern. Monghyr comes under the pattern Pd₃ Pu₄/W₄ and Buxar under Pd₃ Pu₄/W₄ M₄/Ju₄. In Gopalganj, sugarcane area is about 10 per cent. It is included in the crop pattern of this sub-division with paddy, maize and wheat Pd₄ M₄ W₄ S₄/Ba₄. In all, the zone has five cropping patterns
- 4.34 In Monghyr and Patna, rice yields are 70 and 90 per cent of all-India respectively. The rainfall distribution is not adequate for growing rice but the crop is grown under fully irrigated conditions in Patna and 60 per cent in Monghyr. The yield levels reached under these conditions are however low, particularly in the case of Monghyr where it is only equal to the State average and a quarter below all-India. The yield of wheat in Patna and Monghyr are rather low, 84 and 67 per cent of all-India respectively. The yield of maize is nearly the same as all-India. The rainfall distribution is however, satisfactory for a crop like maize. The yield of total pulses is well above all-India. In Patna it is close to 150 per cent and in Monghyr about 130 per cent of all-India.
- 4.35 Goats form a larger constituent of livestock population in Monghyr and Saran districts with pattern G_3 Cm_3 Cf_4/Cy_4 . Shahabad has more male cattle than goats, which form the next highest category, the pattern being Cm_4 G_4 Cf_4 Cy_4 .

Rainfall Zone VII-E₄(A₂B₁C₁)E₄

- **4.36** Gaya is the only sub-division included in this zone.
- 4.37 The area of the zone is 4,950 sq km. and the elevations range between 260 and 550 masl. The soils are recent alluvial.
- 4.38 The annual rainfall is 120 cm in 60 rainy days. July and August receive about 35 cm pm of rainfall,

- which is nearly 60 per cent of annual. Rainfall in September is 20 cm and in June 14 cm.
- 4.39 Paddy covers more than half the area and wheat and pulses are about 13 to 15 per cent each. The pattern is: $Pd_2 W_4/Pu_4$.
- 4.40 Though the entire rice area in Gaya district is irrigated, its yield is low being only 72 per cent of all-India. Only 50 per cent area under wheat is irrigated and its yield is 64 per cent of all-India.
- 4.41 The pattern for Gaya district where male cattle are larger number than the rest is: Cm_4G_4 Cf_4 Cy_4 .

Rainfall Zone VIII— $E_4(A_2B_1C_1)D_1E_3$

4.42 The district, sub-divisions and the cropping patterns in the zone are :

Cropping Pattern	Sub-division	District
Pd4 M4 W4 Pu4/Ba4/S4	Siwan	Saran
Pd3W4Pu4	Arrah	Shahabad
Pd3 W4	Sasaram	,,
Pd2W4/Pu4j	Aurangabad	Gaya
Pd3 M4 Pu4 O4 .	Garhwa Daltonganj Latehar	Palamau ,,
Pd2 W4/Pu4/M4/Mt4	Chatra Hazaribagh	Hazaribagh
Pd2 W4/Pu4/M4/Mt4	Simdega	Ranchi
PdI	Dhanbad Baghmara	Dhanbad

- 4.43 The area of the zone is 46,147 sq km (27 per cent of the geographical area of the State). The average area of a sub-division in this zone is more than 3,000 sq km, the largest area being of Hazaribagh sub-division. (8,600 sq km) and the lowest that of Dhanbad.
- 4.44 Siwan and Arrahare plains with elevations of 60 to 90 masl. In the plateau area, elevations range from 300 to 1000 masl.
- 4.45 Net sown area is only 20 per cent in Palamau and Hazaribad and 30 per cent in Dhanbad. This is due to large areas under forest, land net available for cultivation and fallow lands. Ranchi has 40 per cent net sown area. In the rest of the zone, net sown area is as high as 60 to 70 per cent.
- 4.46 The soils are red sandy in Dhanbad and red and yellow in Hazaribagh, Palamau and Ranchi areas. In the rest of the zone, the soils are mostly recent alluvial.
- 4.47 The annual rainfall is 110 to 130 cm in the plains and 130 to 150 cm elsewhere. The month of maximum rainfall is generally August. July and August together contribute more than 50 per cent of

annual rainfall. Only July to September receive more than 20 cm rainfall. June rainfall is the lowest and October gets more than 5 cm.

- 4.48 Paddy is the major crop of the zone. It occupies 80 per cent of the area in Dhanbad, 55 to 60 per cent in Ranchi, Hazaribagh and Gaya, 35 per cent in Palamau, 45 per cent in Shahabad and about 30 per cent in Saran. The zone has eight cropping patterns-one each with Pd_1 and Pd_4 and three each with Pd₂ and Pd₃. The other crops in the patterns are one or more of wheat, other pulses, maize and other oilseeds. Oilseeds are significant in Palamau district.
- 4.49 Rice yield in Dhanbad is highest being 95 per cent of all-India, elsewhere it is 60 to 75 per cent. In spite of full or nearly full irrigation, yields in Gaya and Shahabad are low. Wheat is grown mainly in the districts of northern plains excepting palamau, a plateau district. Palamau yield is only 54 per cent though 33 per cent of area under wheat is under irrigation. Shahabad yield is 74 per cent with 75 per cent irrigation and Gaya with about 50 per cent irrigation has a yield of 64 per cent. Yield is 70 per cent only in Saran where 60 per cent of area is irrigated. As regards maize, Saran district has the best yield of 120 per cent of all-India and Shahabad has the lowest with 39 per cent. Except for Saran, the yields hardly reach 90 per cent. Pulses have low yields (70 to 90 per cent of all-India) in the plateau districts excepting Dhanbad (109 per cent). in Shahabad is 120 per cent and Saran 130 per cent.
- 4.50 Among livestock, goats predominate in Ranchi, Dhanbad and Saran. The patterns are :

 $\left. \begin{array}{ll} Ranchi \\ Saran \end{array} \right\} G_3 \ Cm_4 \ Cf_4/Cy_4 \\ \\ Dhanbad \\ Hazaribagh \end{array} \right\} G_4 \ Cm_4 \ Cf_4 \ Cy_4 \\$

The rest of the zone has Cm₄ C₄ Cf₄ Cy₄ pattern.

Rainfall Zone $IX - E_4(A_2B_2)D_1E_3$

4.51 The sub-Divisions in the zone and their cropping pattern is given below:

Sub-division Cropping pattern District Pd₂ Pu₄ Gumla Ranchi Khunti

- 4.52 The area of the zone is 8,854 sq km and the elevations range between 450 and 1102 masl. Soils are mainly red and yellow. Red sandy soils are present in the southeastern part of Khunti.
- 4.53 The annual rainfall is 150 to 160 cm in 80 rainy days. July and August together contribute more than 50 per cent of total rainfall.
- 4.54 Paddy occupies more than 55 per cent of the area followed by other pulses (12 per cent). pattern is: Pd. Pu4 for both the sub-divisions, 3-736Agri/76

- 4.55 In Ranchi, yield of rice is 66 per cent of all-India and is nearly the same as the State average. Rice crop was 22 per cent irrigated in 1969-70. The yield of small millets is the same as all-India. The yield of all pulses combined is 83 per cent which is lower than the State average of 109 per cent.
- 4.56 The livestock pattern in Ranchi district is: G₃ Cm₄ Cf₄ Cy₄.

Rainfall Zone $X--D_1E_3(B_2C_2)D_1E_3$

4.57 The sub-divisions and the cropping patterns in the zone are:

Cropping pattern Sub-divisions District Pd₄ M₄ W₄ Pu₄ Bhagalpur Bhagalpur Banka Pd₂ Pu₄ Godda Pd₂ Pu₄ Santhal Parganas

- 4.58 The areas of the sub-divisions vary from 2,300 to 3,000 sq km. In Bhagalpur and Banka, the elevations range between 50 and 400 masl. Godda is more elevated and minimum and maximum heights are 150 and 570 masl. Godda soils are red sandy and mainly recent alluvial elsewhere.
- 4.59 The annual rainfall is 110 to 120 cm in 60 July is generally the month of maximum rainy days. The rainfall distribution in July and rainfall. August is in B class. This is the lowest class in the State.
- 4.60 Godda and Banka have more than 60 per cent area under paddy and 10 per cent under pulses. Godda has 10 per cent of area under maize. pattern for these two is: Pd2 Pu4. Bhagalpur has a number of crops with smaller areas. Paddy and maize each occupy about 25 per cent of the area. Wheat and pulses occupy 15 per cent each. The pattern is: Pd₄ M₄ W₄ Pu₄.
- 4.61 Rice yields in the zone are about the same as, In Bhagalpur district rice is almost entirely irrigated and has a Relative yield Index Value of 96 per cent. Santhal Parganas with only 11 per cent irrigation has the highest yield in the State (105 per Wheat yield in Bhagalpur is low (65 per Relative Yield Index Value of cent) of all-India. Maize in Bhagalpur is 83 per cent with no irrigation.
- 4.62 Goats account for 31 per cent and male cattle 22 per cent of livstock population in Bhagalpur district and the pattern is: G₃ Cm₄ Cf₄/Cy₄. In Santhal parganas also population of goats is predominent and the pattern is: G4 Cm4 Cf4 Cy4.

Rainfall Zone XI— $D_1E_3(A_1B_1C_2)D_1E_3$

- 4.63 The zone comprises of only one sub-division of Deograh of Santhal Parganas. Its area is 2,431 The heights vary from about 400 to 750 masl and the soils are red sandy.
- 4.64 The zone receives annually about 120 cm. July is the month of rainfall in 65 rainy days.

maximum rainfall and with August, accounts for about 50 per cent of annual. There are only two months, July and August, with more than 20 cm pm. rainfall. September and June have less rainfall.

- 4.65 The zone is primarily paddy dominated with about 70 per cent area under it. The pattern is: Pd_1 .
- 4.66 Goats are dominant with 30 per cent of the total livestock in the district and the pattern is: G_4 Cm_4 Cf_4 Cy_4 .

Rainfall Zone XII— $D_1E_3(A_1B_2C_1)D_1E_3$

- 4.67 Madhubani sub-division of Darbhanga district constitutes this zone.
- 4.68 The area of the zone is 3,475 sq km. It is plain area with an elevation of about 60 masl. The soils are recent alluvial.
- 4.69 The annual rainfall is 132 cm in 60 rainy days. July is the month of Maximum rainfall and 50 per cent of annual precipitation is received during July and August.
- 4.70 Paddy area is over 60 per cent followed by pulses the cropping pattern is: Pd₂ Pu₄.
- 4.71 Yield of paddy in Darbhanga district is only 64 per cent of all-India. Less than 10 per cent of crop is irrigated. The low yield may be due to inadequacy of rainfall during September-October.
- 4.72 Darbhanga district has slightly higher percentage of male cattle (26 per cent) followed by goats (25 per cent). The pattern is: Cm₄ G₄ Cf₄ Cy₄.

Rainfall Zone XIII—D₁E₃(A₂B₁C₁)D₁E₃

4.73. The districts, sub-divisions and the cropping patterns in the zone are:

Cropping pattern	Sub-division	District
Pd ₃ Pu ₄ W ₄	Muzaffarpur	Muzaffarpur
Pd ₃ Pu ₄ W ₄	Darbhanga	Darbhanga
$M_3 W_4 Pd_4$	Samastipur	,,
$Pd_3 Pu_4 W_4/M_4$	Saharsa	Saharsa
Pd ₂ M ₄	Giridih	Hazaribagh

- 4.74 The area of the zone is 14,903 sq. km. The sub-divisions vary in are from 1,500 (Saharsa) to 5,200 sq km (Giridih).
- 4.75 Elevations in Giridih are 400 to 600 masl and in the rest of the zone 40 to 60 masl. The soils are recent or calcareous alluvial except for red and yellow in Hazaribagh.
- 4.76 Rainfall in the zone varies from 120 to 150 cm. July and August are the rainiest months with a total of about 60 cm or higher rainfall. These contribute about 50 per cent of annual rainfall.

- 4.77 Paddy is the dominant crop of the zone. Samastipur has been included in the maize pattern because it adjoins two sub-divisions with about 40 per cent maize. Paddy area in Giridih is 59 per cent and area of maize 10 per cent. The pattern is: Pd₂ M₄. In the rest of the sub-division paddy other pulses and wheat constitute the pattern.
- 4.78 Yield of rice in Darbhanga district is 64 per cent of all-India. The yield level should be better as 25 per cent of area is irrigated. Maize yield is 89 per cent and wheat yield is 75 per cent of all-India and about the same as the State average.
- 4.79 In Darbhanga district, livestock population has more male cattle than goats. The pattern is: Cm_4 G_4 Cf_4 Cy_4 .

Rainfall Zone XIV— $D_1E_3(A_1B_2)D_1E_3$

4.80 The sub-divisions and the cropping patterns in the zone are:

lays. per	- Cropping pattern	Sub-division	District
July	Pd_1	Chaibasa Saraikela Jamshedpur	Singhbhum
by	Pd ₂ Pu ₄	Ranchi	Ranchi
	Pd ₁	Sahibganj	Santhal Par- ganas
only nt of	Pd ₂ Pu ₄ /W ₄ /M ₄ /Mt ₄	Dumka	,,
o in-	Pd_1	Jamtara	,,
MIN	Pd ₂ W ₄	Bettiah Motihari	Champaran
cent-	Pd ₂ Pu ₄	Sitamarhi	Muzaffarpur
Cy.	Pd ₃ Pu ₄ W ₄ M ₄ Ju ₄	Supaul Madhepur a	Saharsa "
सुन्यमेव	Pd ₃ Pu ₄ W ₄	Purnea Katihar	Purnea

- 4.81 This is the biggest zone with an area of 50,133 sq km (nearly 30 per cent of the area of the State). The sub-divisions span 7 districts. Singhbhum and Champaran districts are fully included in the zone, along with major portions of Santhal Parganas, Purnea and Saharsa. Besides, the zone includes Ranchi and Muzaffarpur sub-divisions also.
- 4.82 The sub-divisions are partly in the Plateau and partly in the plains areas of the State. The elevations of the two areas are as follows:

Plain	Saharsa Purnea	30 to 65 masl
	Champaran	60 to 75 except in Battiah where maximum is 880 masl in the northwest
Plateau	Santhal Parganas Singhbhum Ranchi	300—500 masl 400—900 masl 560—1,100 masl

4.83 The plateau areas have about 40 per cent net sown area. Forests cover 10 to 25 per cent with land not available for cultivation and fallow lands forming 10 to 15 and 15 to 20 per cent respectively. Net sown area in plains is high. It is over 70 per cent in

Champaran and Muzaffarpur and 60 to 65 per cent elsewhere. Forests are almost absent. Land not available for cultivation is 15 per cent and fallow lands are 15 per cent in Saharsa and Purnea.

- 4.84 In the plains the soils are mostly recent alluvial with a strip of calcareous soils and terai soils in the extreme northwest in Bettiah. Soils are red sandy in Ranchi and Santhal Parganas. In Singhbhum these are red sandy with a major portion of mixed red and black. A small area of red and yellow soils is present in Jamshedpur.
- 4.85 The annual rainfall varies between 125 and 150 cm in 60 to 80 rainy days. July and August are the rainiest months and together contribute more than 50 per cent of total rainfall.
- 4.86 Paddy is the dominant crop of the zone. In the southern sub-divisions paddy occupies more than 60 per cent area: the patterns are Pd₁ in Singhbhum and Santhal Parganas except in Dumka sub-division and Pd₂ Pu₄ in Ranchi. In the northern sub-divisions, paddy is generally less than 50 per cent. The patterns are Pd₂ W₄ in Champaran, Pd₂ Pu₄/W₄/M₄/Mt₄ in Dumka sub-division, Pd₂ Pu₄ in Muzaffarpur, Pd₃ Pu₄ W₄/M₄ Ju₄ in Saharsa and Pd₃ Pu₄ W₄ in Purnea.
- 4.87 The highest rice yield is 105 per cent in Santhal Parganas, followed by 80 per cent in Singhbhum and 60 to 65 per cent in the northern most districts except Purnea which is only 45 per cent. Irrigation is negligible in most of the districts except for Champaran, Ranchi and Saharsa, which have 20 to 25 per cent of Paddy area under irrigation. The yields of wheat are nearly uniform being 70 to 75 per cent except in Champaran where yield is 89 per cent of all-India. The yields are low though irrigation is 40 per cent in Darbhanga to Purnea, 50 per cent in Champaran and 20 per cent in Muzaffarpur. Yield of total pulses in Champaran is 122 per cent of all-India; elsewhere it varies generally between 85 and 100 per cent.
- 4.88 Goat population is predominant in the northernmost districts except in Darbhanga and Saharsa where male cattle predominates. Goats from the Major category in the southern and eastern districts also. The patterns are:

Cm₄ G₄ Cf₄ Cy₄—Saharsa G₄ Cm₄ Cf₄ Cy₄—Santhal Pargans and Purnea G₃ Cm₄ Cw₄ Cy₄/S₄—Res

Rainfall Zone $XV - C_1E_3(A_2B_2)C_1E_3$

- 4.89 Pakur of Santhal Parganas district is the only sub-division in this zone.
- 4.90 The area of the zone is 1,782 sq km. The elevations range between 275 and 570 masl. The soils are red sandy.
- 4.91 The annual rainfall is 160 cm in about 80 rainy days. The maximum rainfall occurs during the months of July and August. All the six months from May to October get more than 10 cm rainfall per month. Both July and August receive higher than 30 cm of rainfall.

- 4.92 Paddy is cultivated on 73 per cent of area followed by maize (9 per cent) and other pulses (9 per cent). The pattern is: Pd₁.
- 4.93 Santhal Parganas district has the highest rice yield in the State being 105 per cent of all-India. Irrigation is only 11 per cent. Rainfall of October (being higher than 10 cm) has to some extent helped in lessening water stress during this period. Maize yield under such good rainfall conditions is only 69 per cent and yield of pulses is 90 per cent.
- 4.94 Goats constitue about 30 per cent of livestock population. Goats and cattle account for 75 per cent in Santhal Parganas district. The pattern is: $G_4 \ Cm_4 \ Cf_4 \ Cy_4$.

Rainfall Zone XVI— $C_1E_3(A_3B_1)C_1E_3$

- 4.95 Araria is the only sub-division of Purnea included in the zone and its cropping pattern is Pd₂ Ju₄.
- 4.96 Area of the zone is 2666 sq km. The elevation is 45-60 masl and the soils are recent alluvial.
- 4.97 This is a zone of good rainfall with about 170 cm rainfall in 73 rainy days. Nearly 50 per cent of the annual rainfall is in July and August. July to September receive more than 30 cm pm rainfall.
- 4.98 Paddy covers 55 per cent of area followed by jute (11 per cent) pulses and wheat (7-8 per cent each). Though paddy and jute add up to a few per cent less than 70, it is combined with adjoining Kishanganj which has about 70 per cent jute area.
- 4.99 Yield of Paddy in Purnea district is the lowest in the State, being less than 50 per cent of all-India. Irrigation is hardly 10 per cent and negligible but rainfall is good.
- 4.100 Livestock pattern of Purnea district is: G₄ Cm₄ Cf₄ Cy₄.

Rainfall Zone XVII—C₁E₃(A₄)D₁E₃.

- 4.101 The zone includes Kishanganj sub-division.
- 4.102 The area of the zone is 1934 sq. cm. The elevations range from 60 to 80 masl and the soils are recent alluvail.
- 4.103 The zone has the heaviest rainfall in the State. The annual rainfall being over 200 cm. July and August rainfall total to about 100 cm. All the months June to September get more than 30 cm pm rainfall. May rainfall is 10 cm or higher.
- 4.104 Paddy occupies 70 per cent of the area followed by jute with 18 per cent. Along with adjoining sub-division of Araria the pattern is: Pd₂ Ju₄. This is one of the very few sub-divisions with jute as a significant crop. Purnea district has the largest jute area in the State.
- 4.105 Yield of paddy in Purnea district is the lowest in the State being only 45 per cent of all-India. Though rainfall in this zone is adequate for growing a crop like rice, the yield is low. Jute is grown on 10 per cent of the cropped area of the district with yield of 71 per cent of all-India. This yield is also low.

5 FUTURE CROPPING PATTERNS—SOME OBSERVATIONS

General

- 5.1 In the foregoing sections we have dealt with in detail the rainfall, cropping and livestock patterns which emerge from the existing information. We have also categorised the rainfall patterns into zones and discussed how the other patterns feature in those zones. Among other information that on soils, which ought to play an important role in determining cropping patterns, is lacking in such details as are wanted for this analysis. Data on orography and population density have featured in this analysis but their exact role on cropping and livestock patterns could not be brought out owing to lack of detailed information. We are, however, convinced that studies and analysis indicated in the preceding sections are important for the guidance they may give in deciding cropping and livestock patterns vis a vis rainfall patterns. The greater the accuracy of the primary information, and the more detailed such information is, the more useful the data would be in drawing up the most efficient cropping and livestock patterns in an area or a zone. With this purpose in view the following procedures are suggested:
 - (i) Delineation of rainfall zones;
 - (ii) Identification of the existing cropping patterns;
 - (iii) Assessment of area needed for each crop and its ideal distribution;
 - (iv) Comparison of (iii) with (ii) in order to determine possible changes; and
 - (v) Consideration of other related factors like soil, irrigation facilities, density of population, livestock patterns and then arriving at the future cropping patterns.
 - 5.2 The methods of delineating rainfall patterns or zones and cropping patterns have been fully discussed in Section 2. For purpose of locating suitable areas for a crop, soil and topography of the land are important factors. The approximate area to be put under each crop will be decided by the demand not only at a State level but at a national level, either for internal consumption or for the purpose of export. The departments responsible for crop planning in the State should, therefore, be cognisant of the demand for a crop, so that production efforts are not rendered futile because of lack of demand and marketing. We have already discussed the part each of the factors mentioned in item (v) of para 5.1 is likely to play in deciding cropping patterns. For this purpose not only detailed data but also knowledge about the correlation between these factors and crop performance would be necessary. Knowledge gained, through long experience, by farmers would also be most helpful.

- 5.3 We ought to mention that the rainfall intervals which form the basis of identifying rainfall patterns are subject to minor modifications. Thus, the condition that 30 cm of rainfall for three consecutive months is good for paddy may not be rigorously adhered to. If the soil is favourable with a high water retention capacity or, what is more important water management is efficient with an eye to economise water use, rainfall lower than 30 cm for three months may sustain a good crop of paddy.
- 5.4 The choice of a cropping pattern is not decided by the farmer only on technical grounds. He is also guided by the profitability of the crops or requirements for his household consumption. Farmers may not be inclined to accept a crop unless the necessary inputs and infrastructure are assured. Of all the inputs water is the most important as is made evident by the spread of groundnut in the country, sugarcane in Gujarat, maize and cotton in Karnataka and recently of wheat in West Bengal. These are excellent instances of the manner of introduction of new crops in the cropping patterns of a State or a region.

Some Observations Pertaining to Bihar

- 5.5 The yields of rice, wheat, sugarcane, barley, gram, jute and maize are below the all-India level in many parts of the State. There appears to be very good scope to improve the yield standards. In relation to crop production, the main problem relates to water management. In general, the amount of rainfall received in the four months of south-west monsoon is either of A₂ B₁ or A₁ B₂ or A₂ B₃ categories. This much could be considered adequate for many crops. The months of May and October also receive rainfall of D type in many places. Howevery, the rainfall of pre and post-monsoon months is not very dependable.
- 5.6 Approximately, the Latitude 25°N divides the State into two halves. The upper half is predominated by Gangetic alluvium while the southern half has soils characteristics of the central plateau. The four types of main rainfall patterns covering the period, May to October, are indicated below:

Rainfall pattern during the period May to October	Number of su	b-divisions
the period way to October	north of L 25° N	south of L 25° N
$D_1/E_1 A_2 B_2 D_1$.	4	8
D_1/E_1 A_2 B_1 C_1 D_1	7	11
$D_1/E_1 A_1 B_2 C_1 D_1$	6	1
$D_1/E_1 A_1 B_1 C_2 D_1$	1	1
	18	21

5.7 The total number of sub-divisions covered by the above mentioned patterns are 39, representing about 67 per cent of all the sub-divisions of the State. Southern Bihar below L25°N has 19 sub-divisions in

 A_2 B_2 and A_2 B_1 categories of rainfall in south-west monsoon months whereas the northern parts have only 11, which should suffice to indicate that southern Bihar is as good as north Bihar sofar as the rainfall is concerned.

5.8 The crop of rice is taken throughout the State, but it suffers heavily in the northern districts of Saharsa, Purnea, Darbhanga, Muzaffarpur and Champaran from riverine floods. The floods are more or less an annual feature and, therefore, it is worthwhile considering whether it is advisable at all to grow rice in the areas adjacent to the northern tributaries of the Ganga. It would be probably advantageous to readjust cropping patterns vis-a-vis paddy throughout the State. Emphasis on entire kharif cropping should be in the areas to the south of the Ganga. The soils in plateau areas are not as fertile as in the north. But this disadvantage could be overcome by the use of required doses of manures and fertilisers. By adopting improved technology relating to crop production including increasing use of plant protection measures, it should be quite possible to achieve much higher production levels of kharif crops including rice even with the exclusion of the intensely flood prone areas of the north. Alternate cropping patterns should be conceived and tested for their suitability in different regions. In the new scheme it should be seen that rice crop is confined throughout the State to the low lying areas or where it is possible to ensure a constant supply of irrigation water. All other areas must be diverted from paddy to comparatively less water requiring crops like maize, soyabean and urid or similar crops. Sugarcane area can be increased and so also the area under various oilseeds. Niger could be popularised during kharif season and safflower during rabi after paddy.

5.9 In riverine tracts of the north, crops could be grown during rabi and summer season in general with the exception of jute. Summer cropping should not be difficult in the receding riverbeds and in other neighbouring areas with the help of irrigation from wells.

5.10 Jute should be continued to be grown in northern districts, specially Saharsa and Purnea. The farmers are aware that, if the jute crop has attained an age of about two months before heavy rainfall occurs, it is able to withstand the same, barring of course, situations where the crop is liable to be washed away altogether. It should be feasible to start the crops of jute in the month of May with the support of premonsoon rains and/or irrigation. If the crop could be sown in May, it is possible to achieve the objective mentioned earlier. Farmers do adopt this approach wherever feasible, but this practice has to be scientifically established and popularised.



APPENDIX 1

Districtwise Livestock Population—1966

BIHAR

(Thousands)

Dist	trict		Cattle	:	Bu	iffaloe	s	Sheep	Goat	s Horses	Mule	_		Pigs	
		Male	Fe- male	Young stock	Male		Young stock	-		& ponies		keys	els		live- stock
1	Bhagalpur	235		186 (17)	30 (3)	54 (5)	41 (4)	22 (2)	331 (31)	6 ()	— (—)	 			1075
_	~~								542	5	()		(-)		1601
2	Champaran	416 (26)	205 (13)	178 (11)	16 (1)	109 (7)	89 (6)	15 (1)	(34)	()	— (—)	3 (0·2)	- (-)	13 (1)	-
3	Darbhanga	468 (26)	280 (16)	282 (16)	1	153 (9)	109 (6)	10 (1)	438 (25)	6 ()	_ (~-)	1 ()	<u>-</u> ()	11 1	1759
4	Dhanbad	128	90	87	37	12	6	82	133		_		_·	16	591
		(22)	(15)	(15)	(6)	(2)	(1)	(14)	(22)	()	(—)	()	(—)	(3)	
5	Gaya	586 (25)		336 (15)	93 (4)	166 (7)	142 (6)	131 (6)	484 (21)	2 (—)	— (—)	1 (—)	— (—)	69 (3)	2311
6	Hazaribagh	439 (21)	321 (16)	402 (19)	148 (7)	53 (3)	38 (2)	57 (3)	544 (26)	2 ()	_ ()	 ()	 (-)	57 (3)	2061
7	Monghyr	366	269	291	31	88	64	26	483	8			_	30	
		(22)	(16)	(18)	(2)	(5)	(4)	(2)	(29)	(0 ·5)	()	(—)	(—)	(2)	
8	Muzaffarpur	470 (28)	191) (11)	177 (10)	2	138 (8)	97 (6)	11 (1)	608 (36)	4 ()	— ()	5 ()	<u> </u>	7 (
9	Palamau	308 (26)		- 1	11 (1)	68 (6)	44 (4)	71 (6)	248 (21)	7 ()	 ()	 (_)	(—)	27 (2)	
10	Patna	276	120	150	27	129 (12)	110 (10)	25 (2)	263 (23)	5 (1)	— (—)	2 (—)	— (-)	27 (2)	
11	Ranchi	483	301	246	Williams	53	40 (2)	120 (6)	676 (31)	4 ()	 ()	_ ()	<u> </u>	91	2154
12	Saharsa	342	2 26:	5 236	4	104	79	4	293	16	_		(-)	(4) 8	135
. 3	Conthel Dargana	(25)			90	(8) 80	(6) 66	243	(22) 845	(1) 8	()	()	()	(1)	
13	Santhal Pargana	(19)			(3)	(3)	(2)	(9)	(30)	(—)	()	()	- (-)	196 (7)	
14	Saran	335 (25)			<u> </u>	130 (10)	86 (6)	31 (2)	419 (31)	7 (0·4)	 ()	-	<u> </u>		1352
15	Shahabad	457 (28	247	240	1 ()	193 (12)	142 (9)	125 (8)	202	7		8		23	1645
16	Singhbhum	426	3 238	195	68	16	10	261	558	(1 ·4)		_			1797
		(24)			(4)	(1)	(31)	(14)	(3)		()	(—)	()	(1)	
17	Purnea	659 (27			34 (1)	117 (5)	97 (4)	14 (1)	733 (30)	28 (1·1)	 ()	 ()	— (—)	21 (0·9)	

Note: Figures in brackets represent percentages to total livestock.

APPENDIX 2

Rainfall and Cropping Patterns—BIHAR

BIHAR

Cropping patterns	District	Sub- division	Arca E in	levation (mast)		m- A ial			Rainfall		nsceuti	ve mor	iths*
			sq ~ km	max r	nin r f	otal ain- all cm)	ber of	mum rain-	tive modineluding the modern of maximal plus the ceding of succeed month we ever is leave to the control of the	g ith num e pre- or ing which	(a)	(b)	(c)
									cm	No. o rainy days	ſ		
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Rainfall Zone—	-1							Rainfa	ll Pa	ttern—	$E_4(B_2C)$	₂)E ₄
Pd_3W_4	Patna	Bihar	2079	119	48	105	52	8		27	64	91	42
$Pu_3Pu_4W_4$		Barh	1425	119	48	96	51	8	• -	25	6 4	83	41
	Rainfall Zone-			• •	• •								D_1K_3
Pd ₄ M ₄ W Ba ₄	Saran	Chapra	2665	77	68	105	53	8	3 57	27	64	91	43
	Rainfall Zone	30	웃됐	Sign	3							$4(A_1B_1C_1)$	- ,
Pd ₂ Pu ₄	Gaya	Nawada	2629	667	446	103	57	8			64	88	46
	Rainfall Zone-												
$Pd_4M_4W_4Pu_4$	Muzaffarpur	Hajipur	2012	51	46	108	5 4	8	58	27	6—4	94	44
	Rainfall Zone-	V	77NV	144			• •	٠.	Rainfall	Patter	r_n-E_4	$(A_1B_2C$) E ₄
Pd ₂ Pu ₄ /W ₄	Gaya	Jehanabad	1420	310	94	109	55	8	8 63	28	64	95	44
	Rainfall Zone-	<i></i> ν7		49.172	3				. Rainfall	Patteri	n—E,($A_1B_2C_1$	D_1E_2
Pd ₄ M ₄ W ₄ S ₄ /Ba ₄	Saran	Gopalganj	2019	76	68	110			7 58	26		94	41
$M_3W_4Pd_4$	Monghyr	Begusarai	1921	48	37	120	60		8 60	29	64	102	38
Pd ₃ Pu ₄ W ₄		Monghyr	2885	252	50	11:	5 58	8 8	59	29	64	97	4
$M_3W_4Pd_4$		Khagaria	1472	40	36			_			_		_
$Pd_2Pu_4/W_4/M_4/Mt_4$		Jamui	3377	651	252	114	4 60	8	7 59	30	64	96	48
Pd ₃ Pu ₄ /W ₄ /M ₄ /Ju ₄	Shahabad	Buxar	1551	89	71	105	51	;	8 60	27	64	92	42
Pd ₃ Pu ₄	Patna	Patna sada	r 136	48	47	117	56	8	8 62	27	6-4	101	45
		Patna city	664	48	47			-		_	_	_	_
		Dinapur	1126	48	47	108	51	8	3 59	26	64	94	42
	Rainfall Zon	eVII					••					$(A_2B_1C$	
Pd ₂ W ₄ /Pu ₄	Gaya	Gaya	4950	545	266	118	60	:	8 70	32	64	104	49

^{* =} Consecutive months with rainfall of more than 10 cm per month.

masl=metres above sea level.

a =Initial month with more than 10 cm of rainfall and number of consecutive months with more than 10 cm per month separated by hyphen.

b =Total rainfall of consecutive months under 'a' in cm.

c =Total number of rainy days of consecutive months under 'a'.

Notes: 1 Information on rainfall and rainy days based on Memoirs of India Meteorological Department, Vol. XXXI Part III,

² For explanation of coded form of rainfall and cropping patterns, reference may be made to section 2 in the text,

APPENDIX 2 (Contd.)

	2	3	4	5	6	7	8	9	10	11	12	13	14
والمرابع المحمول والمرابع المحمول المرابع المرابع المرابع المرابع المحمول المح	Rainfall Zone-	-VIII				••		R	ainfall .	Patteri	$n - E_4$	$A_2B_1C_1$	D_1E_3
$Pd_4M_4W_4Pu_4/Ba_4/S_4 \ .$	Saran	Siwan	2280	77	68	116	55	7	64	28	6-4	100	44
Pd ₃ W ₄ Pu ₄	.Shahabad	Arrah	2254	84 460	58 85	117 123	58 57	8 8	65	30 30	6-4	101 107	47
Pd_3W_4	**	Sasaram Bhuaba	3425 3594	460 440	325	116	56	8	71 66	30	64 64	107	46 46
Pd ₂ W ₄ /Pu ₄	.,. Gaya		3253	225	94	126	56	8	7 4	30	6-4	111	46
$Pd_3M_4Pu_4O_4$. Palamau	Garshwa	4051	569 584	139	121 124	62 64	87 8	68 71	31 33	64	103	49
	"	Daltonganj Latehar	4308 3663	1022	139 360	132	67	87	71 73	33	6—4 6—4	106 111	50 52
$Pd_2W_4/Pu_4/M_4/Mt_4$	" Hazaribagh	Chatra Hazaribagh	4002 8598	767 975	461 308	134 134	67 75	8	75 67	34 35	6-4 6-4	115 108	52 57
Pd ₁	Dhanbad	Dhanbad	1403	745	360	131	72	87	67	34	64	108	55
		Baghmara	1555	745	360	113	61	78	57	30	65	101	52
$Pd_2W_4/Pu_4/M_4/Mt_4$	Ranchi	Simdega	3761	67 5	491	158	84	7	91	41	64	134	66
212	Rainfall Zon	<i>e—IX</i> Gumla	5321	1102	656	 147	 82	7	Ruinfall 76	<i>Pati</i> 38		E ₄ (A ₂ B ₂) 119	$D_1E_3 = 62$
Pd ₂ Pu ₄	Ranchi	Khunti	3533	796	450	161	83	8	86	38	65	142	68
	Rainfull Zone-											$E_3(B_2C_2)$	
Pd ₄ M ₄ W ₄ Pu ₄	Bhagalpur	Bhagalpur	2377	399	55	108	57	8	51	27	6-4	.3(D ₂ C ₂) 88	45
Pd ₂ Pu ₄	Diagaspas	Banka	3021	399	55	120	62	7	58	29	6-4	97	49
1 021 04	Santhal- Parganas	Godda	2274	567	154	109	62	7	50	28	6-4	87	48
	Rainfall Zone-	−XI	RE	254	3			Rain	fall Par	ttern-	$-D_1E_3(A)$	$A_1B_1C_2$	D_1E_3
Pd ₁	Sanghal- Parganas	Deogarh	2431	753	391	122	66	7	58	31	6-4	97	51
	Rainfall Zone			7			• •	Rain		tern-		$A_1B_2C_1$	D_1E_3
Pd_2Pu_4	Darbhanga	Madhurban	i 3475	69	54	132	60	7	67	27	64	111	56
	Rainfall Zone	1.00	. 2101	707								$A_2B_1C_1$	
Pd ₃ Pu ₄ W ₄	Muzaffarpur Darbhanga	Muzaffarpui Darbhanga	2264	59 47	50 43	121 126	56 57	87 8	64 65	27 27	6—4 6—4	104 107	45 45
$M_3W_4Pd_4$	Dat ollanga	Samastipur	2870	45	43	148	60	8	78	30	64	128	49
$Pd_3Pu_4W_4/M_4$	Saharsa	Saharsa	1491	56	48	_	_				_		
Pd_2M_4	Hazaribagh		5177	605	388								
	Rainfall Zone-		• •		• •		• •					$E_3(A_2B_2)$	D_1E_3
Pd_2W_4	Champaran	Bettiah Motihari	4298 3956	830 75	72 65	125 131	54 57	7—8 7	67 7 0	26 27	6-4	106	43
D.i. Do	,, Muzaffarpur		2507	73 70	58	139	58	7	69	26	6—4 6—4	112 116	45 44
Pd ₂ Pu ₄ Pd ₁	Singhbhum	Chaibasa	5206	918	561	132	75	7	65	33	6-4	104	55
	23	Seraikela	7577	538	423	131	68	87	66	31	6-4	104	51
m. m	" Ranchi	Jamshedpur Ranchi	3554 5394	926 1057	524 661	144 151	78 81	78 7	73 77	35 37	6-4 6-4	117 122	57
Pd ₂ Pu ₄ Pd ₃ Pu ₄ W ₄ /M ₄ Ju ₄	Saharsa	Supaul	2375	65	48	140	61	7	66	28	6- 4		60 47
FU31 44 114/11140 04	**	Madhepura	1649	43	136	137	60	7	66	27	6-4		47
$Pd_3Pu_4W_4$	Purnea	Purnea Katihar	3180 3008	45 45	33 33	149	71	7	70 —	32	5—5	132	61
Pd_1	Santhal- Parganas	Sahibganj	1979	440	363	140	65	87	63	30	65	124	55
Pd ₂ Pu ₄ /W M ₄ /Mt ₄	Dumka		3678	506	330	_			•	_	_	_	
Pd ₁		Jamtara	1772	474	296	138	74		65	34	64		58
	Rainfall Zone-		1703			150		R	ainfall	Patter	$n-C_1L$	$E_3(A_2B_2)$	
Pd ₁	Santhal- Parganas	Pakur	1782	567	276	158	78	87	69		56	147	70
	Rainfall Zone-		•••			1.00		Ra -	infall	Patter.	$n-C_1E$	$E_3(A_3B_1)$	D_1E_3
Pd ₂ Ju ₄	Rainfall Zone Purnea Rainfall Zone-	Araria	2666	62	 45	169	 73	7	infall 80 Rainfall	33	55	$E_3(A_3B_1)$ 153 $E_1E_3(A_4)$	63

Area under Principal Crops (per cent of Gross Cropped Area)-1969-70 APPENDIX 3 BIHAR

District/ Sub-division	Gross F cropped area (000 ha)	Pd	ЭК	j - ;	8	Σ	~	*	쿒	Ξ	C	⊢	P.ª	S	5	0	O	. . .	<u> </u>	To	Ju	Misc.
f	Rainfall Zone—I	one—	_	•:·		:		:		:		:		:		:		Rainfa	Rainfall Pattern— $E_4(B_2C_2)E_4$	tern—	$E_4(B_2($?)E4
Fatna Bihar Barh	248 ·9 161 ·1	46 24	1.1	1.1	1.1	- ==	-1	10		0 ·3 0 ·3	60	0.3	33.4	0.1	11	-7	1.1	11	4	1.1	11	64
	Rainfall Zone-	!one—II	11	:		:		:		:		:		:		:	Ra	Rainfall Pattern— $E_4\left(B_2C_2 ight)D_1E_1$	Patteri	$1-E_4$	(B_2C_2)	D_1E_1
Saran Chapra	246 -9	23	ı	1	1	23	-	16	7	73	3	S	က	7	i	-	0.5	1	0.1	1	1	∞
	Rainfall Zone—III	Zone—	Ш	:		:		:		:		:		:		:	R	Rainfall Patterns— $E_4(A_1B_1)C_2E_4$	Pattern	S-E4	(A_1B_1)	C_2E_4
Gaya Nawadah	201 -1	47	ŧ	: 1	0.1	71	7	=	-	ŗ	₩.	-	53	_	0.1	-	i	1	0.1	i	Ì	
	Rainfall Zone-IV	_one	AI	:		:		:		:		:		:		:	Ra	Rainfall Paterns-E4 (A1B1C2)E4	Patern	S-E4	$(A_1B_1$	$C_2)E_4$
Muzaffarpur	1,150	ç	,		-	7.		13	r	_	6	,	9	r	9	-	ı	1		ŗ	1	7
najipur	Rainfall Zane—V	Zone	J .		ł	;	स्र	1	1			1	2	١ ;		· :	Rai	Rainfall Patterns—Ex $(A,B,C)E$,	Pattern		(A.B.	1965
Gava	in format			:			प्रम		1		ne S	F				•				•	7-1	4
Jehanabad	144 · 1	99	i	I	}	7	व ज	∞		ı	2	180	13	7	1	-	i	ı	0.5	1	1	8
	Rainfall Zone-VI	oue-	Z	:		:	यन							:		:	Rainfa	Rainfall Patterns— E_4 ($A_1B_2C_1$) D_1E_3	terns—	E4 (A	$_1B_2C_1$	D_1E_3
Saran						,	1)		9												
Gopalganj	199 -9	32	I	l	1	17		11	7	ec.	-	す	æ	oo	1		ī	1	0.1	0 · 1	0.1	9
Monghyr						* ,			•	٠,	,			(
Begusarai Monehyr	231.5 6.152	<u>ښ</u>	1 1	1	1 1	40	۱ ۳	17 7	77		91	∾ ⊶	4 8	0 4 7	1 1		1 1	1 1	7.5		1 1	2
Khagaria	120.2	32.2	0.1	1.1	٦	% ×	0.3	19	ωr	-15	4 c	44	45		11		1.1	1 1	0 4	11	11	· en c
Shahabad	o oct	5			•	•	•	,	l	•	ı	ı	ļ	ı								1
Buxar	214 ·5	43	-	ì	-	ĸ	J	24	7	-	4	-	14	-	١	71	ı	ì	0.3	i	1	m
Patna																						
Patna Sadar Dinaput	100 ·8 141 ·9	43	1+	11	1.0	77	0·1 0·2	8 01	0 4 2	1-	mm	0.3	33	0 4.5	1 1		11	1.1	0.4	11	11	N 4
	Rainfall Zone—VII	Zone-	-VIII	:		;		:		:		:		:		:	Rai	Rainfall Pattern-	Pattern		$-E_4$ $(A_2B_1C_1)$	1) E4
Gaya																						
Gaya	343 ·6	26	1	i	ı	m .	-	13	-	1	3		15	2	-	2	1	1	0 ·1	ı	1	e
Pd=paddy Jk=jowar kharif Jr=jowar rabi B=bajra			22524	M=maize R=ragi W=wheat Ba=barley Mt=small	M=maize R=ragi W=wheat Ba=barley Mt=small millets	ets	•		:	OFECO:	G=gram T=tur Pu=othe S=sugare Gn=gro	G=gram T=tur Pu=other pulses S=sugarcane Gn=groundnut	S ±			ಶಭಾಧ≥	O=other oilsee C=cotton L=plantations F=fodder Misc.—miscell	O=other oilseeds IC=cotton IL=plantations F=fodder Misc.—miscellaneous crops	ds	T J crops	o=to u=jut	To=tobacco Ju=jute ps

W= wheat

Ba = barley

Mt = small millets

Note: The percentage figures have been rounded off individually and hence cross totals may not, in some cases, add upto 100.

APPENDIX 3 (Contd.)

District/	Gross	Pd	J.	1	æ	×	2	≱	20	Mit	Ů	H	Pu	S	GD	0	ပ	ı	F To		Ju Misc.	Sc.
Sub-division	cropped area ('000 ha)			!	1	}													l			1
Correct	Rainfall Zone—VIII	l Zone-	-7111	:		:		:		:		:	<u> </u>	:		:	Rain	fall Pat	Rainfall Pattern— $E_4(A_2B_1C_1)D_1E_3$	4(A2B1	$C_1)D_1$	E
Siwan	218.9	6 2	l	Į	Į	8	7	15	11	£,		S	æ	5	Į	-	0.1	í	0.1 0	0.1	l	9
Snaravad Arrah Sasaram Bhabua	288.9 397.4 232.7	04 4 4 24 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	1 0 1	111	0 4 5	E	00.1	22 22 22 23	7	0.1	977		16 15 15		151	44%	111	111	14-	111	111	4 11 11
Gaya Aurangabad	273.2	52	ı	1	1	.~◀	0 -4	15	, ma l	1	4	-	20		ļ	2 0	0 · 2	1	0 · 1	1	}	7
Palamau Garhwa Dallanganj Latehar	107 ·6 126 ·3 75 ·3	34 34 34	0.1	111	:: I	14 13	7-7	49=	r40	12 4 15	L 0 m	L-04	≈ <u>7</u> 1 ≈	0.12	111	11 8 12 0	115	111	111	111	111	200
Hazaribagh Chatra Hazaribagh	65 ·6 206 ·0	56 59	0.2	11	11	12	en en	4 5	0.5	mr	10.4	61 -	7		11	4 w		11	11	11	11	63
Dhanbad Dhanbad Baghmara	48 ·6 45 ·7	79 79	11	11	0.2	7.9	m 4	0.3	H	11	0.5	0.1	w4	0 ·1 0 ·1	11	100	11	1.1	11	11	11	w w
Kanchi Simdega	150 · S 59 0 · Rainfall Zone—IX	59 Zone-	0 · 2 -IX	1 :	0 ن	व जयते	m (L	0.2		: B	25	₩ :	12	: 1	0.5	. 5 R	0 ·2 Rainfall	0·2 – – Rainfall Pattern–E4	 n—E4 ($\begin{array}{ccc} - & - \\ (A_2B_2) & D_1 \end{array}$		2 E3
Khunti	220 ·1 56 159 ·4 61 Rainfall Zone—X	56 61 Zone—	11 %	11:	11	1004 T-44 .	7 9	0 3	1.0	o2 :		ω 4 ;	8 2	11:	<u>:</u>	0 - S 	0 · 1 — Rainfall	_ _ I Patter	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\frac{-}{E_3}(B_2($	C2) D ₁	24 E
Bhagalpur Bhagalpur Banka	208·0 184·5	55 62	H	11	11	53	0.5	15	3 6		30	T T	15	7.1	11	74	11	11	0:1	11	11	62
Santhal Parganas Godda	129 ·1	63	1	1	=	10	0.3	1	7	1	73	-	14	0 ·3	1	7	l	İ	1	, I	l	73
Santhal Parganas	Rainfall Zone—XI	Zone-	<i>-XI</i>	:		:		:		:		:		:		. R	infall I	Pattern	Rainfall Pattern— $D_1E_3(A_1B_1C_2)D_1E_3$	(A_1B_1)	23) D1	E
Deogarh Dharthanea	93 ·S Rainfal	93 ·5 71 — Rainfall Zone—XII	-XII	1:	0.4	٠ :	-	- :	ì	4 ;	0.4	4.0	14	t :	0 ·1	~ :	ainfall	– Pattern	Rainfall Pattern— $D_1E_3(A_1B_2C_1)D_1E_3$	(A ₁ B ₂	$C_1 D_1$	E_3
Madhubani	304 ·3 64 – Rainfall Zone—XIII	64 Zone–	- <i>XIII</i>	ı :	1	۲۰ ;	'n	9:	64	1:	-	- :	∞	? ;	1	: 1	_ ainfall	1 Patter	Rainfall Pattern— $D_1E_3(A_2B_1C_1)D_1E_3$	(A2B1	C_1	7 E3
Muzaffarpur	2.17.2	39	١	I	ı	13	-	10	7	~~	0.3	7	13	-	1	-	1	ı	0.2 0	0.4	0.5	11
Darbhanga Samastipur	210 ·8 297 ·0	51 26	11	1.1	11	7.27	1	10	6 1 60	14	2 -	64%	10	1111	11	212	11	11	0.5	11	0.1	6 15

Saharsa	136.0	41	I	l	ı	<u>i</u> 6	4	10	7	per	0.3	-	17	0.3	ł		I	}	1	I	.4	
Hazaribagh Giridih	126 · 3	59	61	l	j	6	71	-	0.3	9	-	-	∞	0.3	1	7	ŀ	}	1	1	1	
	Rainfall Zone—XIV	Zone-	AIX	:		:		:		:		:		:			Rainfall Pattern— D_1E_3 (A_2B_2)	l Patte	rn-D	$_1E_3$ (,	4_2B_2	D_1E_3
Champaran Bettiah Motihari	446 ·0 458 ·1	25.5	11	11	1 1	50	0.1	14	27		0.2		20	3 7 KG	1 1	96	11	1 1	1.1	[]	=-	
Muzaffarpur Sitamarhi	285.7	56	1	I	1		. 7	٠	·	- 1		-	15	. 7	i	. 4	ı	1	0.1	ı	0.1	_
Singhbbum Chaibasa Seraikela Jamshedpur	190 ·2 121 ·4 125 ·9	82 87 86	111	111	0 0 3	Umm	411	0.3	111	m010	0.3	0 4 0 · 1 0 · 3	964	111	111	е-	111	111	111		111	
Ranchi Saharsa	251 -3	62	I	ł	0.1	4	∞	=	0 ·1	S	4. 0	ы	∞	1	0 • 1	0 -4	ļ	i	i	I	1	
Supaul Madhepura	167·2 179·7	24 6	11	1.1	11	5 16	νm	10	44	4 m	0.1	0 0 0 0 0 0	17 14	1-	11		11	1 1	1.1	11	5.6	
Purnea ' Furnea ' Katihar	312.0 212.5	45 54	11	11	11		0 4.5	6 <u>0</u>	21 %	0.4	71	0.3	10 11	١٣	1.1	44	П	1 1	1.1	11	9.9	•
Santhal Parganas Sahibganj Dumka Jamtara	80 ·1 157 ·8 68 ·8	71 88	111	111		904	1	رة ا ا	711	0-	0 2 û l	1	0144	-11	111	1	111	111	111	111	111	
0.000	Rainfal	Rainfall Zone—XV	AX-	:		:		:		:		:		:		:	Rainfall		Pattern— C_1E_3 (A_2B_2) C_1E_3	C_1E_3 ((A_2B_2)	, C ₁
Santnat Farganas Pakur	103 ·6	73	ļ	ł	7	9	1	-	-	0.3		-	9	l	1	2	l	I	1	1	1	
1	Rainfal	Rainfall Zone—XVI	-XVI	:		:		:		:		:		:		:	Rainf	Rainfall Pattern— $C_1E_3\left(\mathcal{A}_3B_1 ight)D_1E_3$	tern-	C_1E_3 ((A_3B_1)	D_1
Purnea Araria	256 ·6	55	1	1	I	1	-	90	-	0.5	9.4	0.5	7	0.5	1	7	l	ł	Į	ı	11	13
	Rainfal	Rainfall Zone—XVII	-XVII	:		:		:		:		:		:		:	Raii	Rainfall Pattern— $C_1E_3(A_4) D_1E_3$	attern-	$-C_1E_3$	3	D_1E_1
Purnea Kishanganj	156.2	70	1	1	1	0.3	0.3			0.3	0.3	ł	2	J	7	J	ţ	1	i	l	188	, ,



सन्यमेव जयते

	R	Cotton	·
	В	Groundnut	Gn
llets	мŁ	Other oilseeds	0
narif)	JК	Sugarcane	S
sbi)	Jr	Barley	Ba
	M	Tobacco	To
	W	Jute	Ju

ng pattern consists of one or more crops, each ubscript which indicates the percentage area of concerned. The total area of the crops is about 70% r.

t Percent of Gross cropped area

greater than 70

50 - 70

30 - 50

10 - 30

less than ' 10

सन्धमेव जयते

Pattern

Pu4 W4

Paddy

Other Pulses

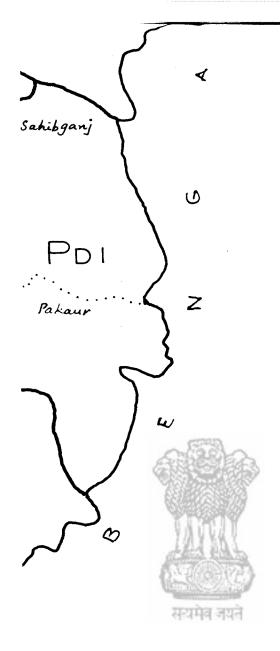
Wheat

Area percent

20-50

Wheat

10-30



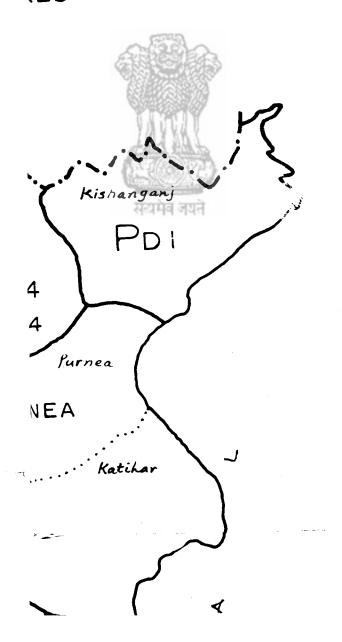
	LEC	SEND	
	Symbols	Crops	Symbols
ons	Pd L	Gram Tur	G T
liets narif) sbi)	R B Mt Jk Jr M W	Other pulses Cotton Groundnut Other oilseeds Sugarcane Barley Tobacco Jute	Gn O S Ba To Ju

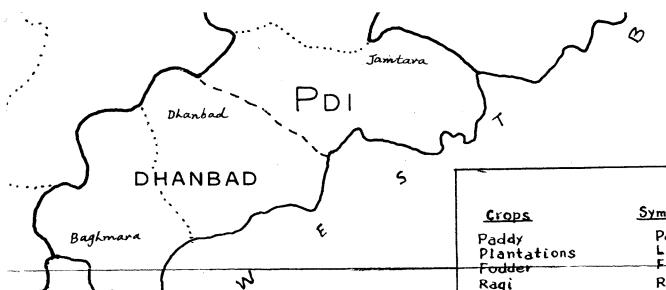
ng pattern consists of one or more crops, each ubscript which indicates the percentage area of concerned. The total area of the crops is about 70%.

LL LE CALCE CYORDED AFRA

NS

RES







Crops	Symbols
Paddy	Pd
Plantations	Ļ
Fodder	
Ragi	R
Baira	В
Small Millets	MŁ
Jowar (Kharif)	JK
Jowar (Rabi)	J۲
Maize	M
Wheat	W

A cropping pattern consist. with a subscript which income the crop concerned. The total or higher.

Subscript	Per
1	

2

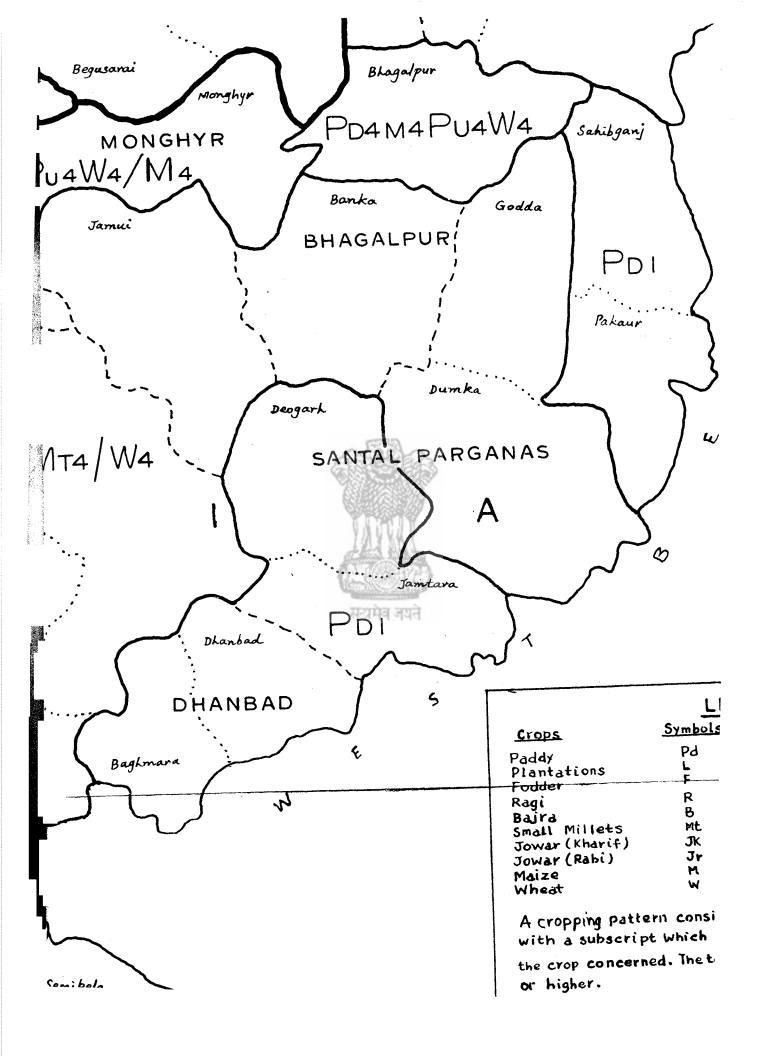
3

4 5

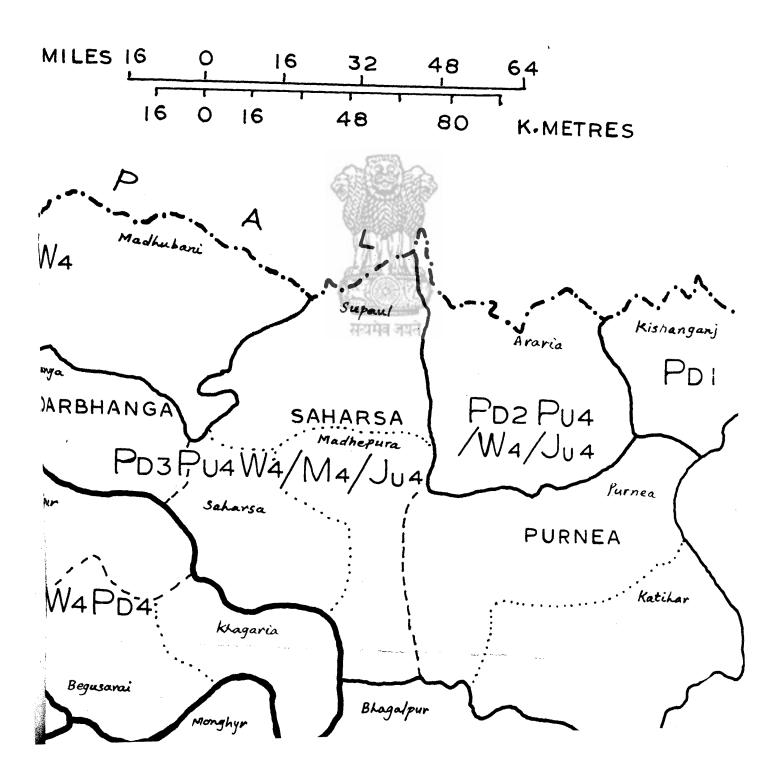
Example:

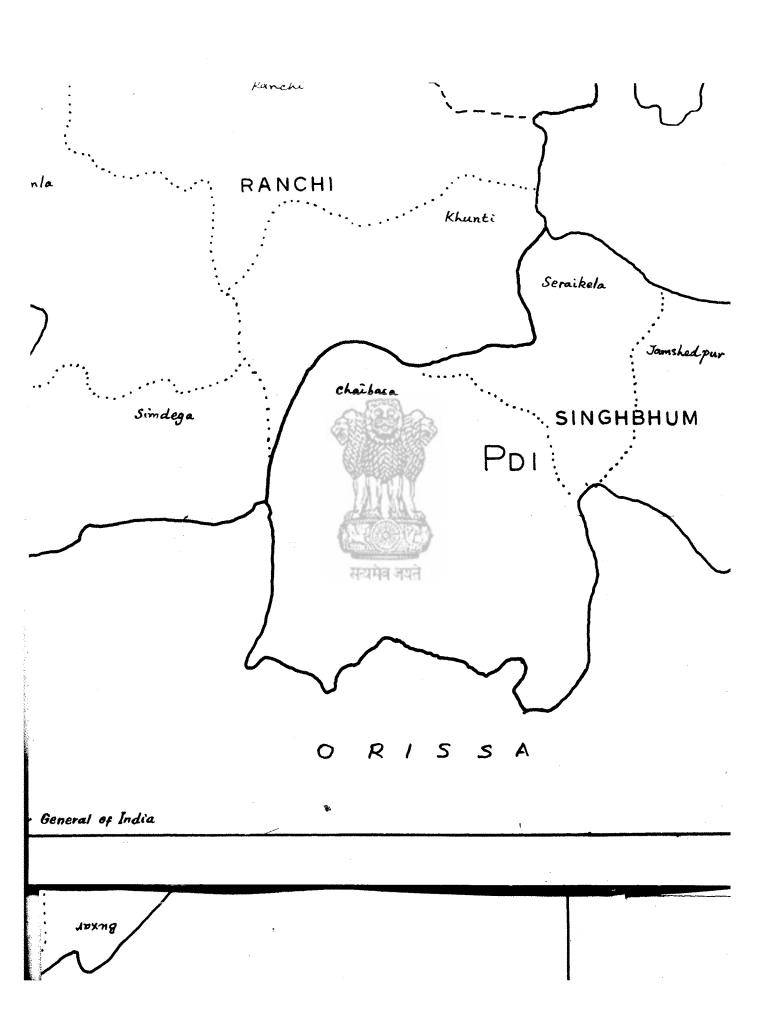
Pattern

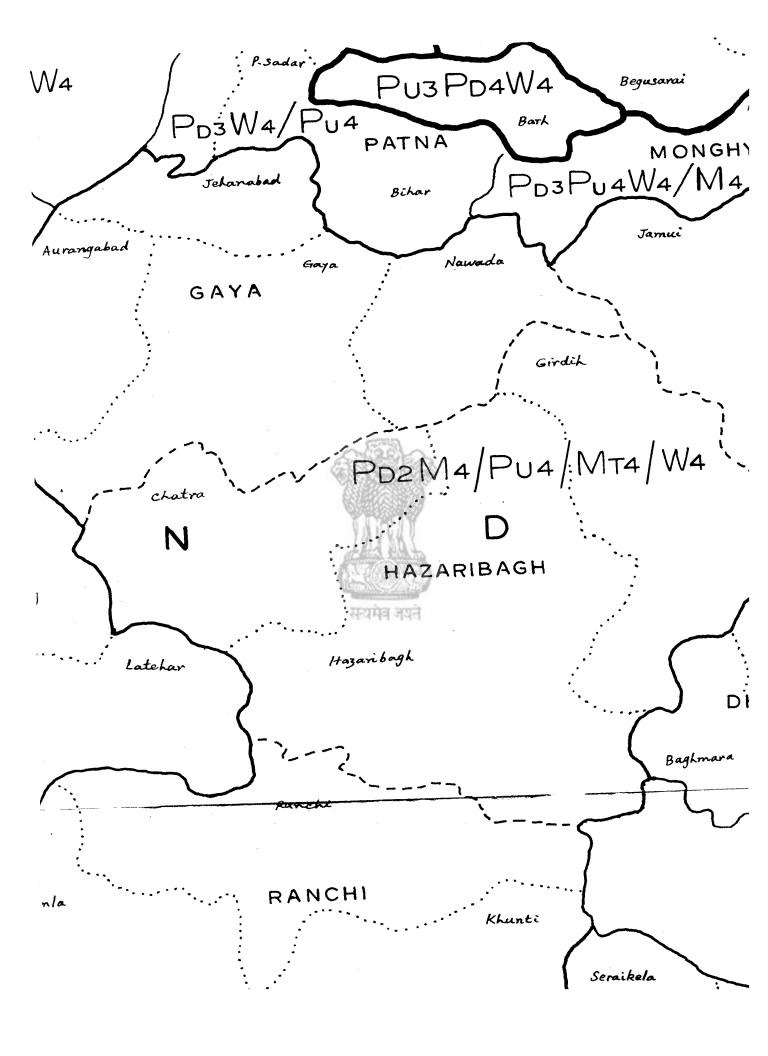
Pd3 Pu4 W4

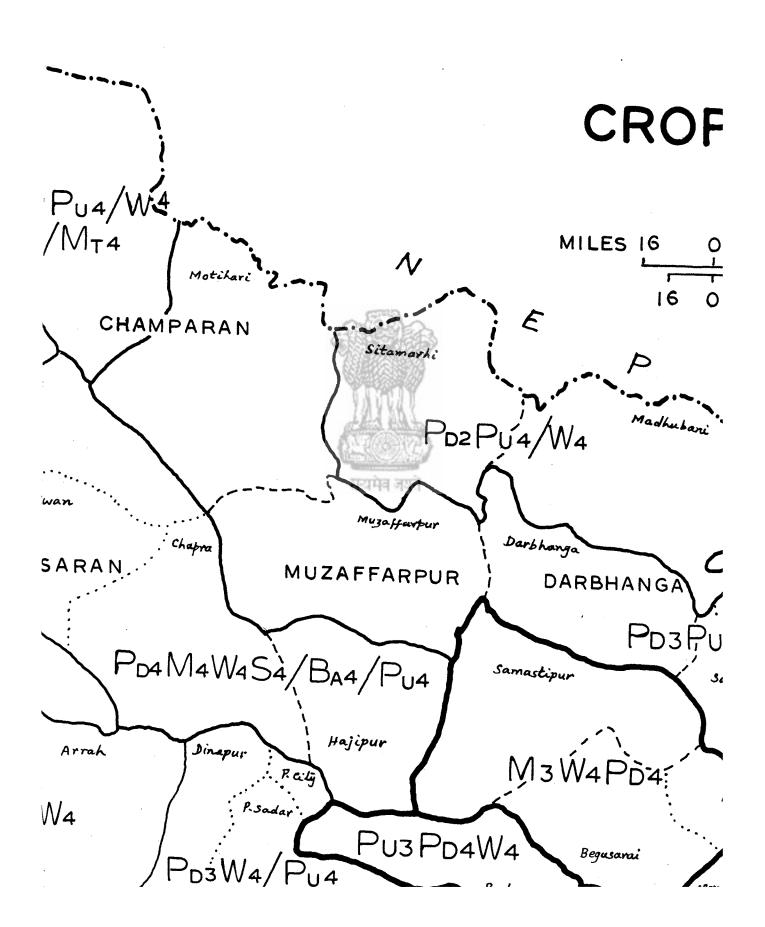


BIHAR CROPPING PATTERNS









-. -. INTERNATIONAL BOUNDARY

- STATE BOUNDARY

--- DISTRICT BOUNDARY

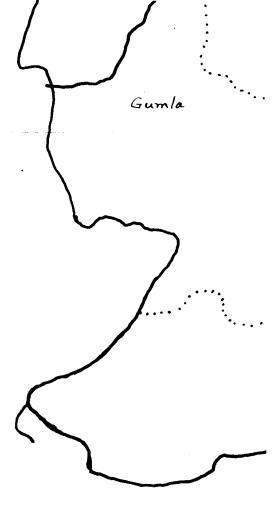
····· SUB-DIVISIONS

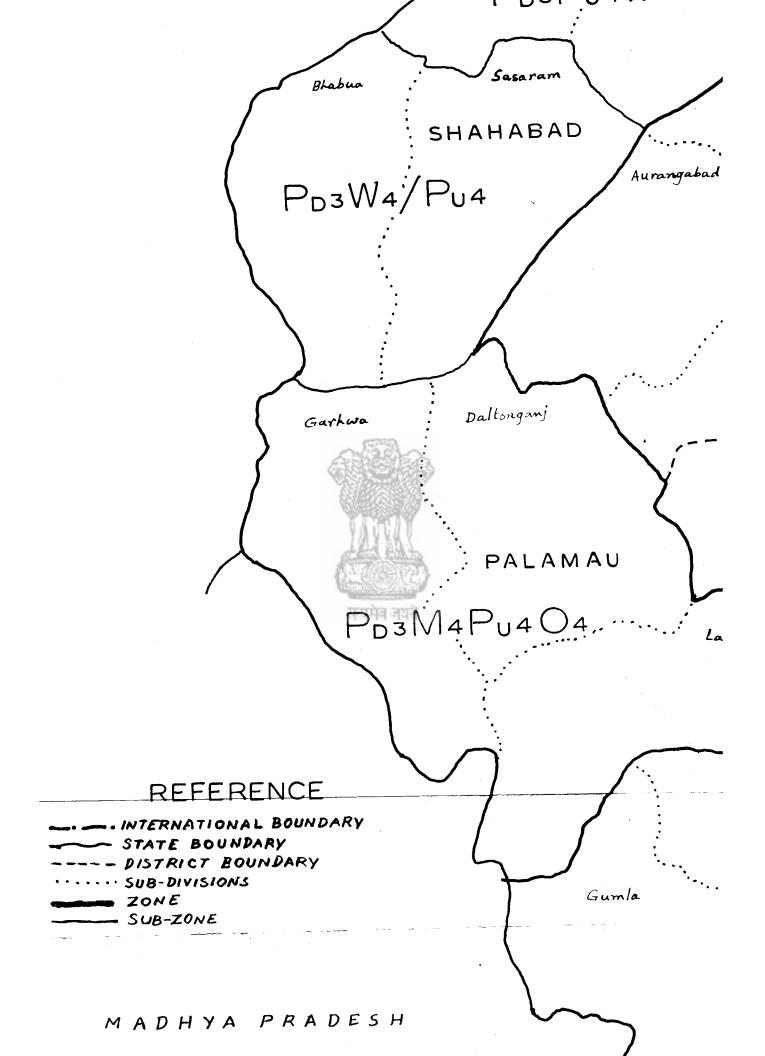
ZONE

- SUB-ZONE

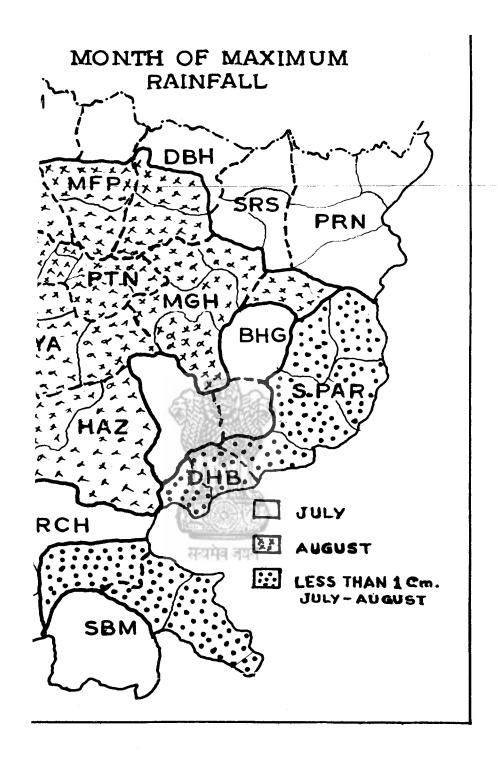
MADHYA PRADESH

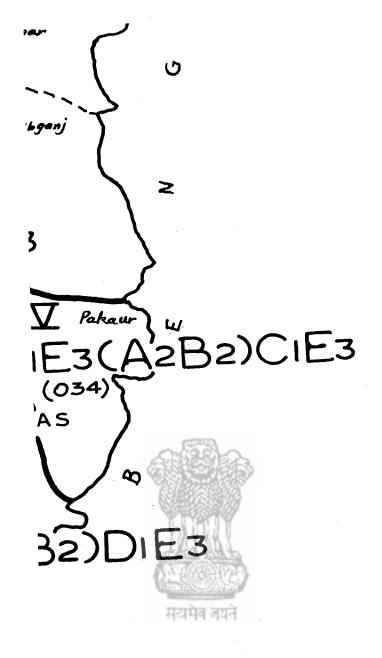


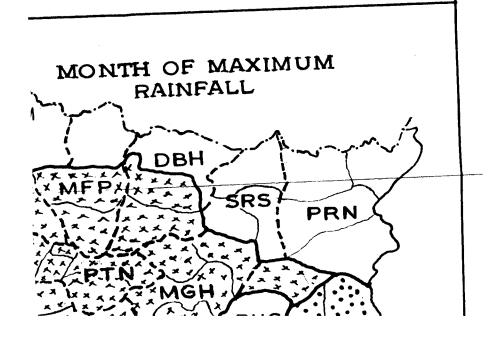


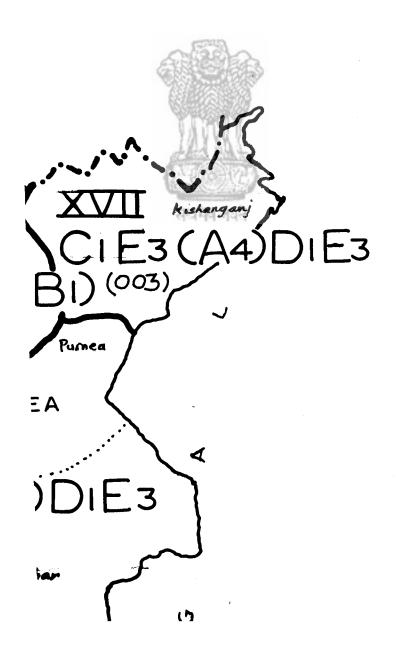


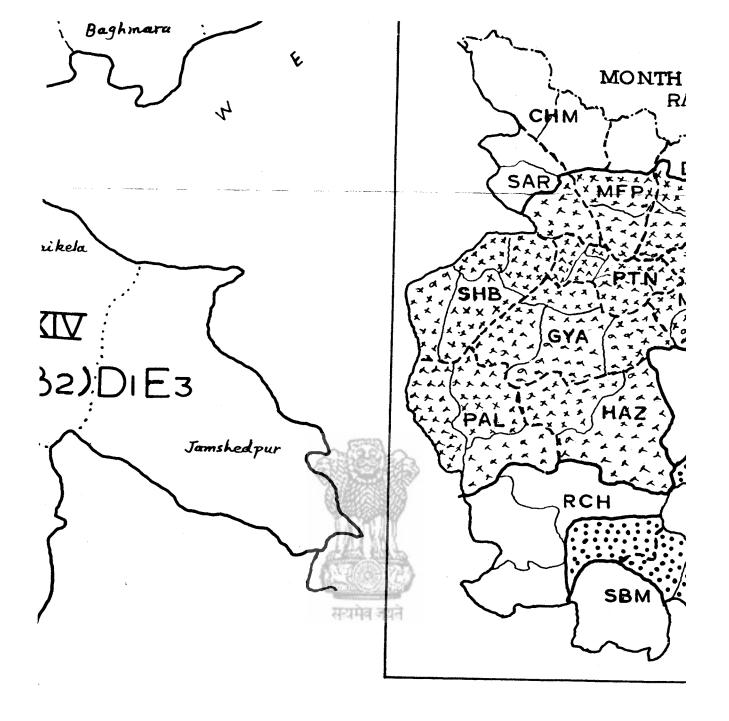






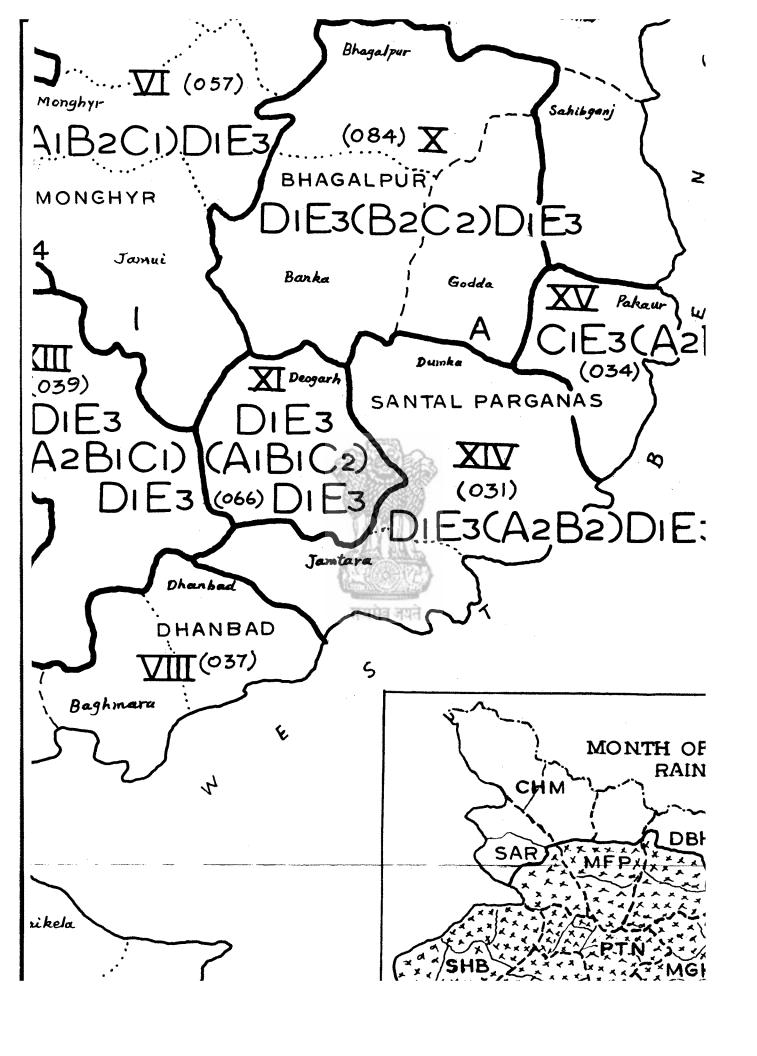




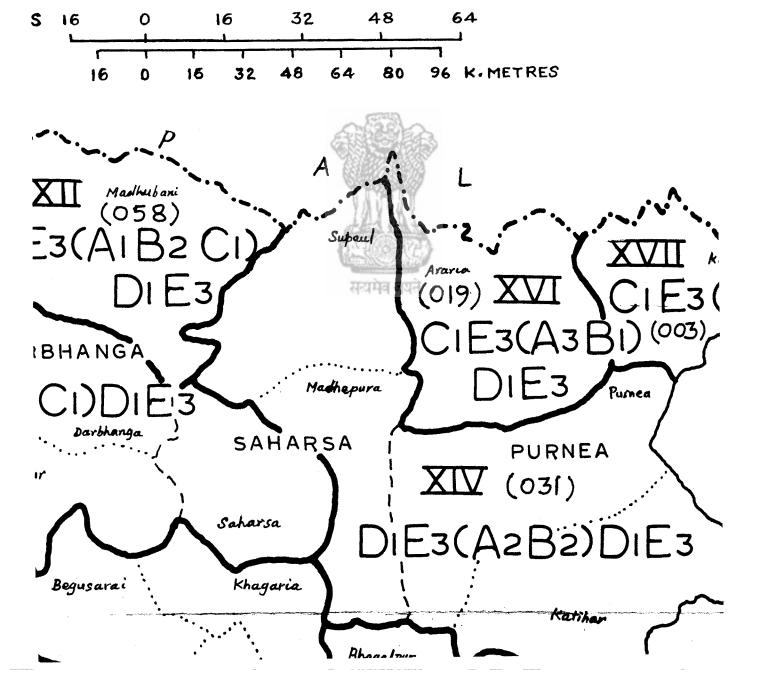


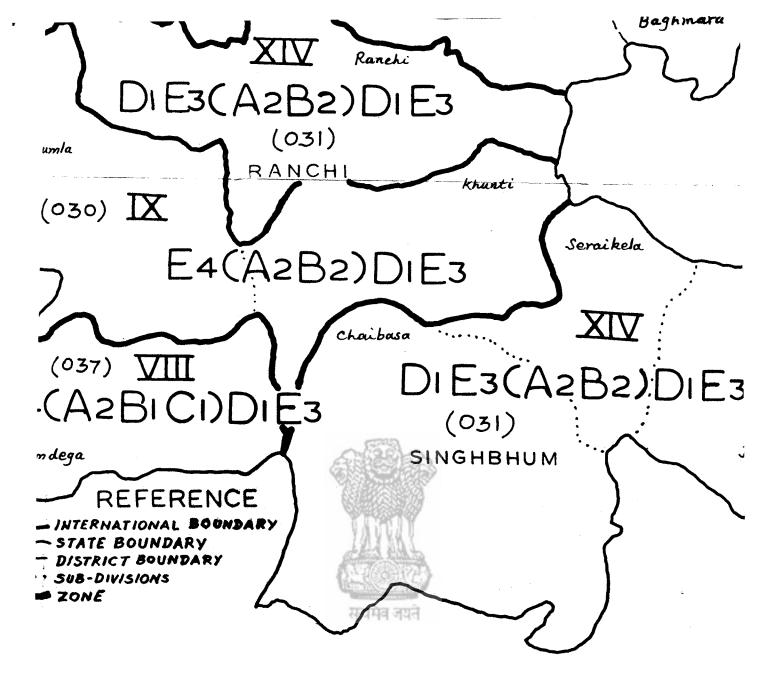
The coded form of each pattern consists of three groups corresponding to the three seasons February to May, June to September and October to January. The central is entered in brackets.

The area covered by a rainfall pattern is termed a zone and the zones in the map are sevially numbered Roman numbers indicate state Rainfall Zones. Three-digit figures in Arabic numerals within brackets give their corresponding all-India equivalents.



BIHAR INFALL PATTERNS





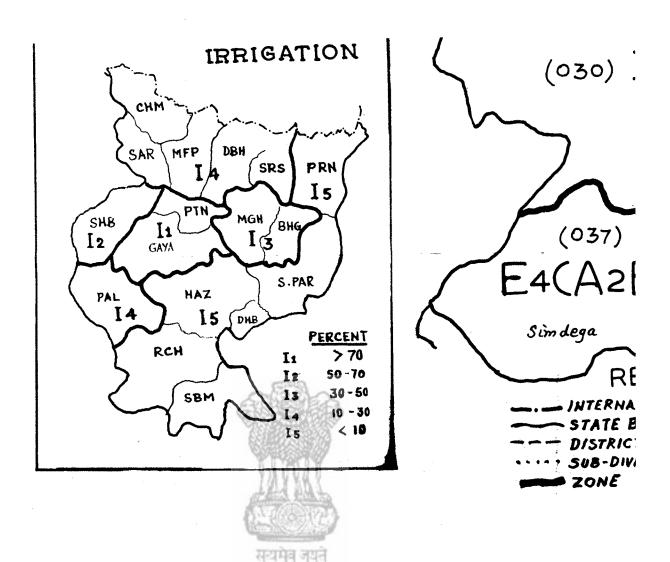
ORISSA

lof India.		LEGEND	
each	Symbol A B C D E	Rainfall interval, centimetres per month > 30 20-30 10-20 5-10 < 10 if the pattern begins with A or B < 5 if the pattern begins with C, D or E.	The coded groups correspond May, June to Sept central is entere The area a zone and the Roman num! Three-digit fill give their correspond



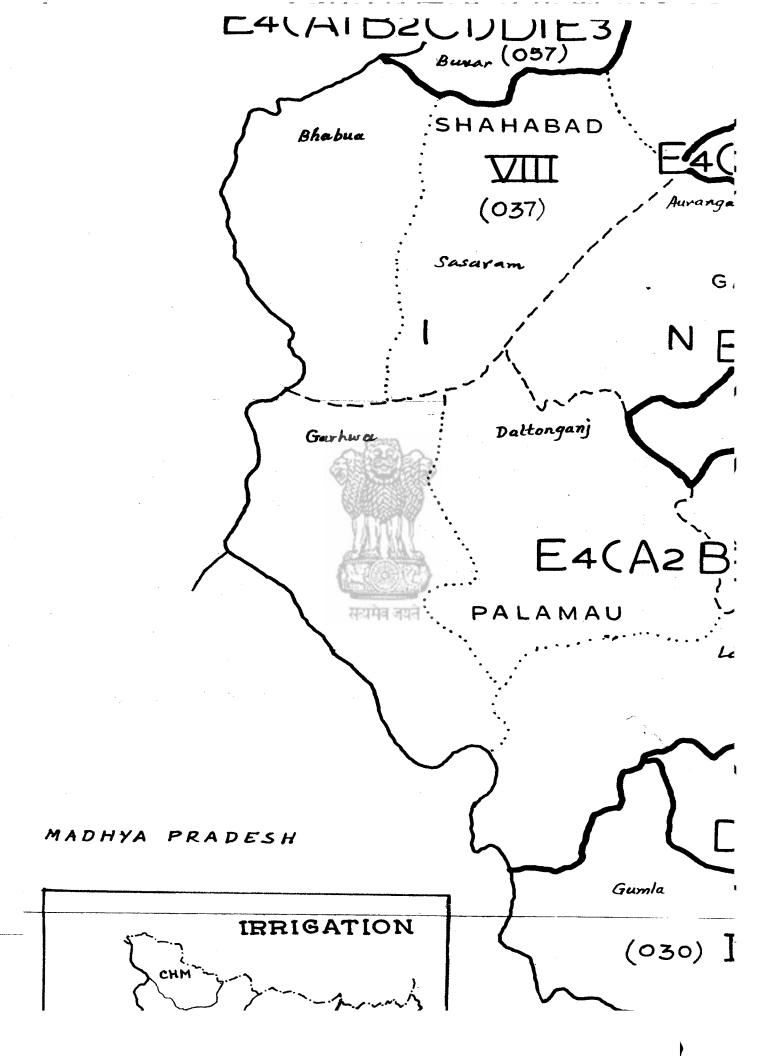
RAINFA

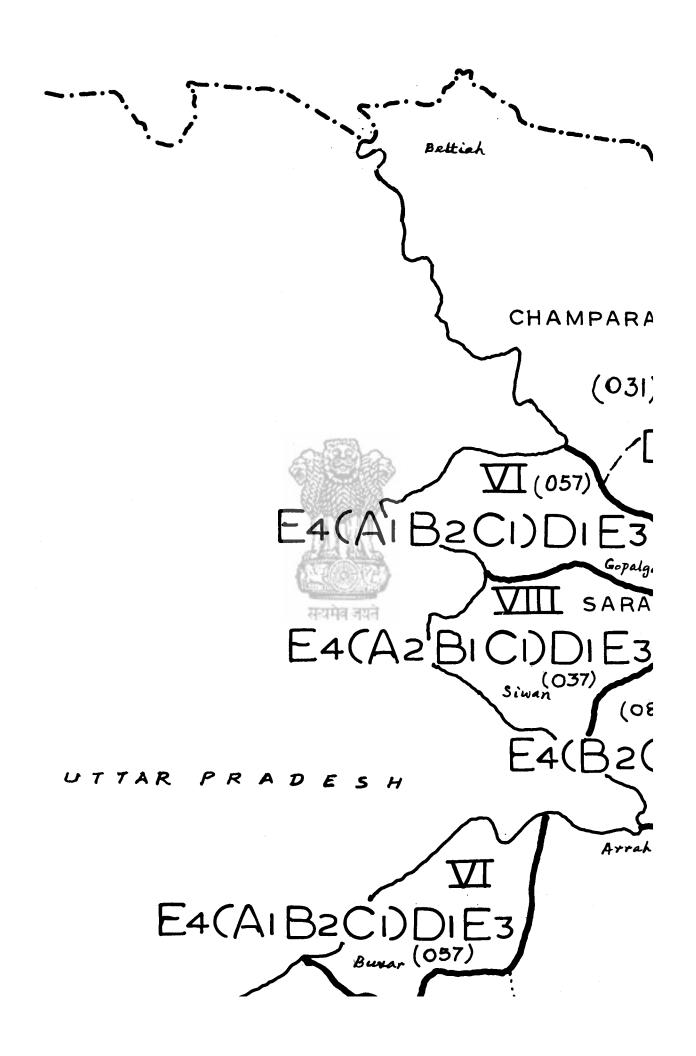




Based upon Survey of India map with the permission of Surveyor General of India.

The rainfall pattern which describes the distribution of monthly rainfall throughout the year is expressed in coded form with letter symbols and numerical subscripts. A letter denotes a rainfall interval and the subscript to each letter the number of months in the interval.





END

under	Symbols Cm Cf Cy Bm Bf By
	Cf Cy Bm Bf
	Cy Bm Bf
	Bm Bf
under	Bf
under	- ·
under	Ву
	S
	G
	н
1	М
5	D
	ca
	P
the percenter to the pe	re of the animals mentioned ch indicates the percentage otages of the categories of ach of them is also 10 peracoff the subdivision/district.
Percent of	f total livestock
greater H	nan 70
	50 -70
	30-50
	10-30
less than	10
G4 Cf4 C	Y4
<u>64 Cf4 C</u> 10-	
<u>G4 Cf4 C</u> 10- 10-	74 -30 %



END

Symbols	>

Cm

Cf

under Су

Bm

Bf

under Ву

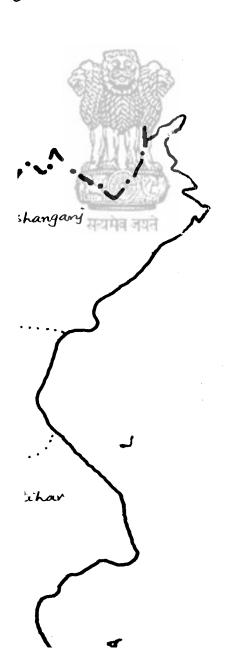
S G

н

M

D

 $c_{\mathbf{a}}$



Livestock

Cattle: Males over 3 years

Femalesover 3 years

Youngstock 3 years and under

Buffaloes:

Males over 3 years

Females over 3 years

Young stock 3 years and under

Sheep

Goats

Horses ponies

Mules

Donkeys

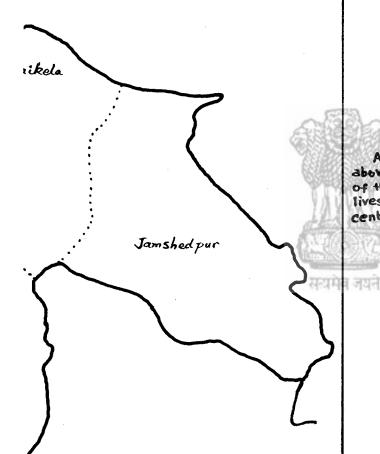
Camel

Pigs

A livestock pattern consists of one or mo above in symbols, each with a subscript whi of the total livestock. The total of the percer livestock in the pattern is not less then 70; ecent or higher of the total of the livestock

Subscript	Percent o	
1	greater H	
2		
3		
4		
5	less than	

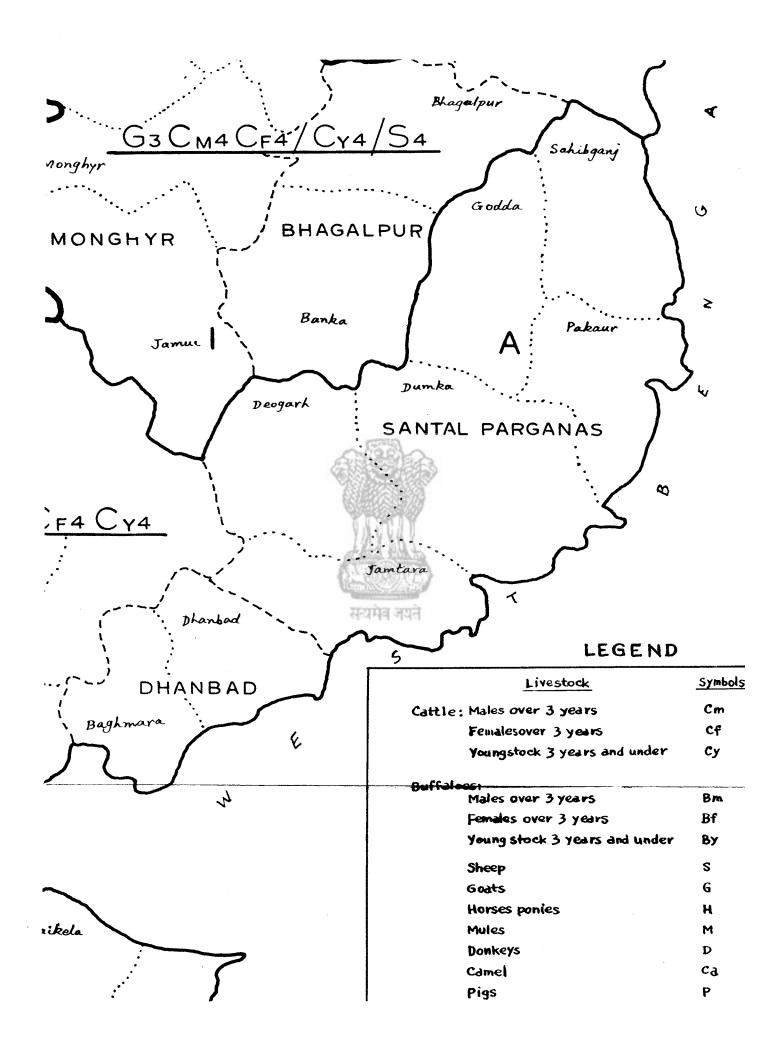
Example:	Pattern: Cm4 G4 Cf4 C	
Cm4	Male cattle	10-
64	Goats	10-
Cf4	Female Cattle	10 -
Cy4	Youngstock Calife	10



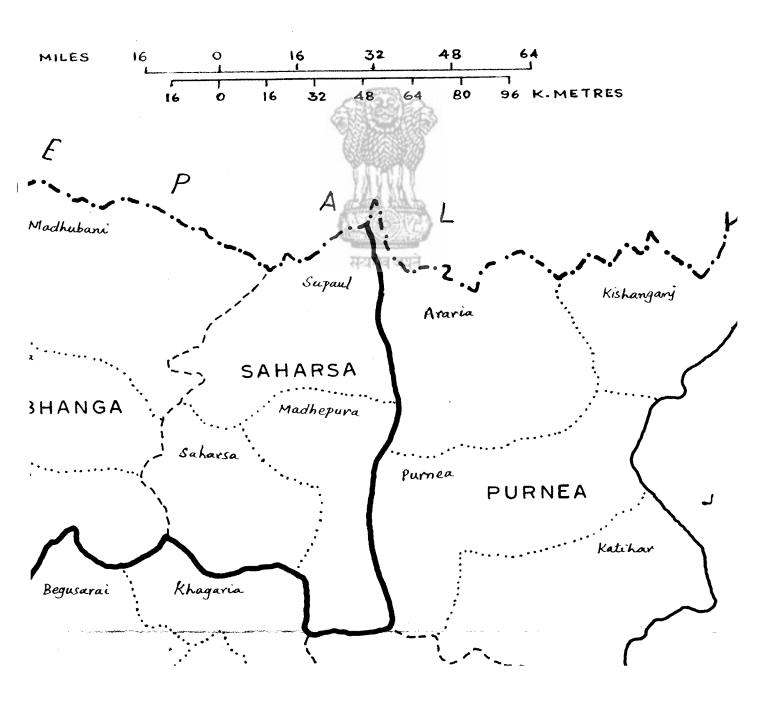
DHANBAD

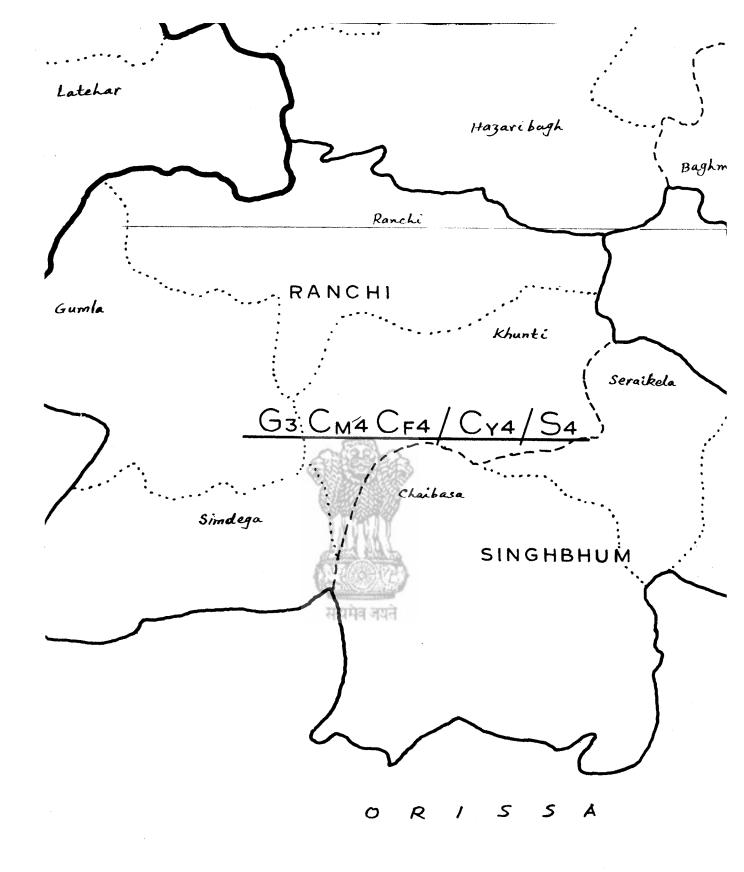
4

Baghmara



BIHAR LIVESTOCK PATTERNS





eral of India

